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707 AND 720 CABINS provide for club-like lounges forward and aft. They can be replaced by additional seating. Boeing jetliners combine passenger-pleasing luxury with economical flight and maintenance features that add up to profitable operations for airlines.

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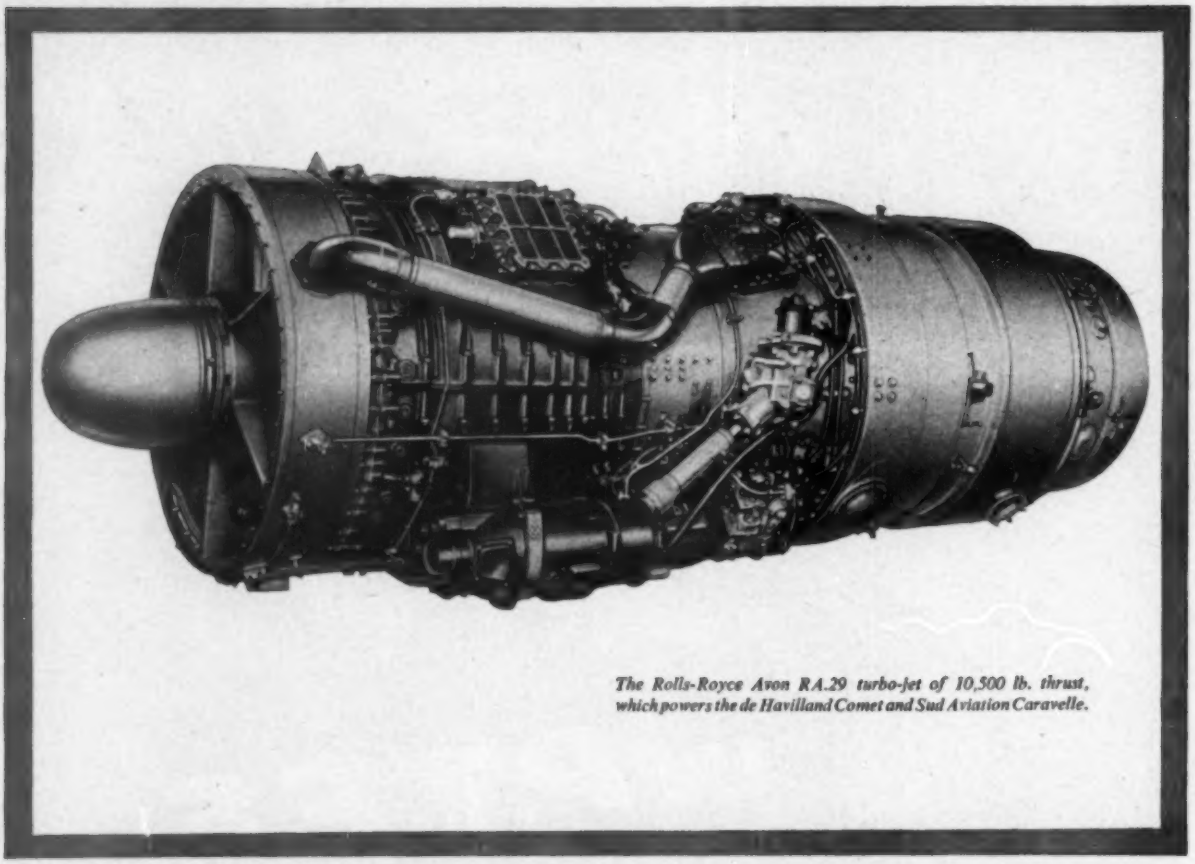

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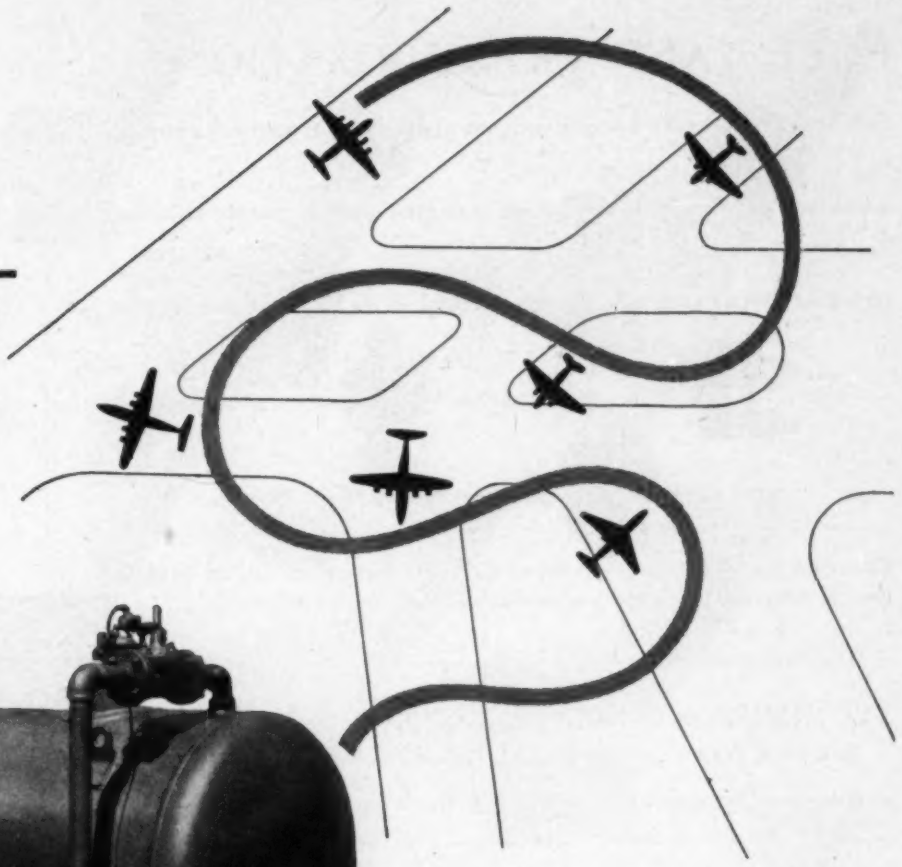

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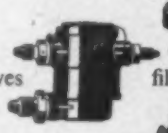
Fuel Tank Pressurisation Systems, designed to meet various operational requirements such as nitrogen blanketing and tank pressurisation, include servo and non-servo systems using servo control valves pressure reducing valves  filter/restrictor valves air or air/nitrogen control valves servo and direct acting vent valves.

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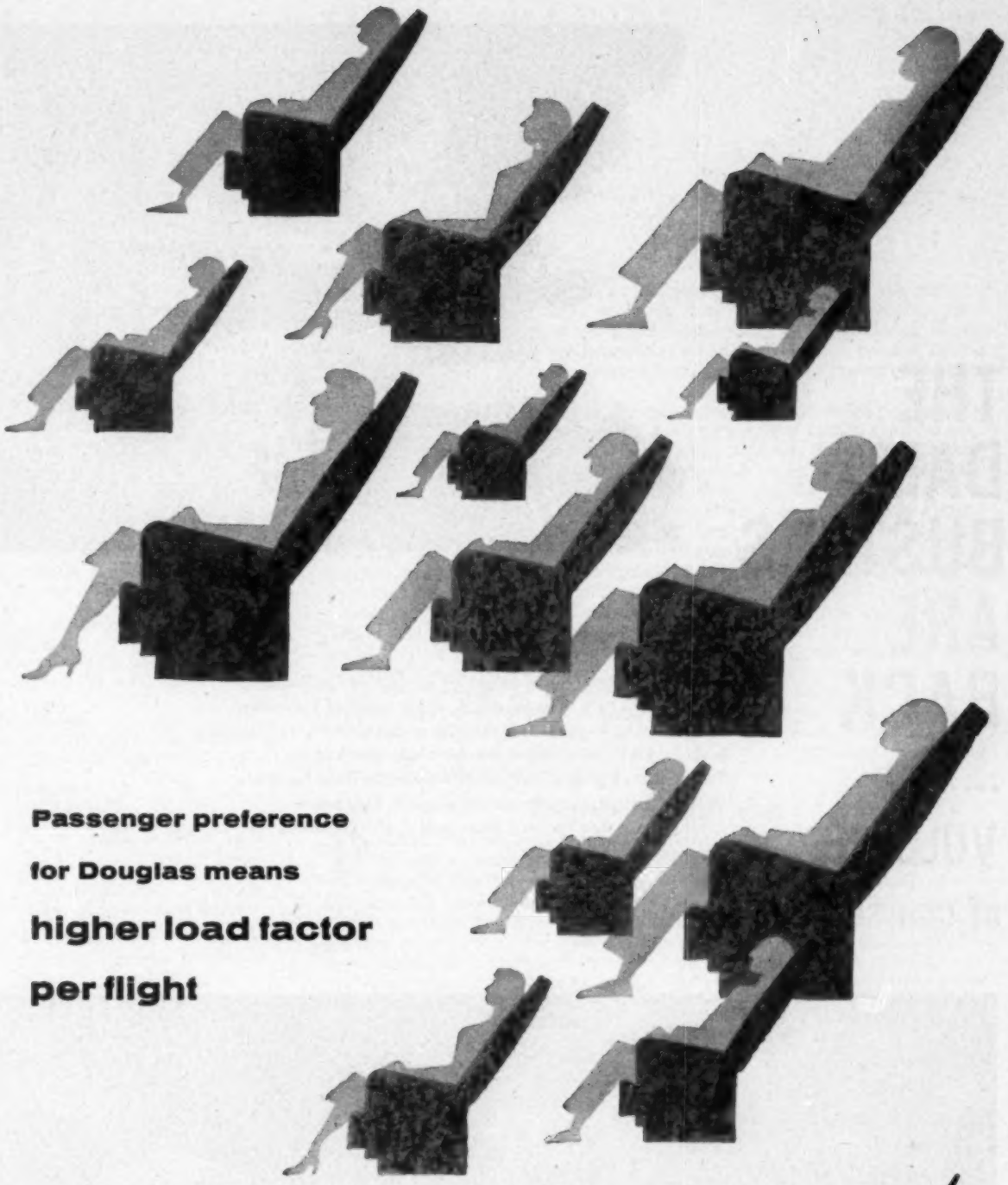

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FIRST AERONAUTICAL WEEKLY IN THE WORLD FOUNDED 1909

FLIGHT
and
AIRCRAFT ENGINEER

No 2586 Vol 74 FRIDAY 15 AUGUST 1958

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London, S.E.1
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New York, N.Y.
Thomas Skinner and Co. (Publishers), Ltd.
111 Broadway, 6
Telephone · Digby 9-1197

ANNUAL SUBSCRIPTION
Home £4 15s 0d, overseas £5 0s 0d
Canada and U.S.A. $15.00.

Second Class Mail privileges authorised at New York, N.Y.

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Fixed-Price Overhaul

At least one airline—a British independent operator—regards the impartial analysis of airliner direct operating costs so highly that it is prepared to undertake such work on a contractual basis. Many different factors influence operating costs, and to arrive at a realistic figure is a specialized task calling not only for wide experience but perhaps also for a degree of cynicism in the study of published figures.

Not the least of the unknowns are the engineering costs to be estimated for a new aircraft type and the amount of servicing help that can be expected from the manufacturers; every aircraft constructor, says this airline, should carry a pool of immediately available spares and cater for a *genuine* 24-hour technical assistance service, even at the expense of an additional £40,000 or £50,000 on first cost. Spread over a depreciation period of seven or ten years, the increase represents a very small amount on cost per flying hour or per seat-mile; and it should be more than repaid by better aircraft serviceability and higher utilization.

The next step may be to follow the engine manufacturers' lead (formulated by Pratt and Whitney and General Electric, Bristol and Rolls-Royce) and establish a fixed cost per aircraft flying hour for, say, overhaul at the constructor's works. This would give airlines a realistic basis on which to calculate aircraft profitability, even if they eventually carried out the overhaul work themselves. The difficulties are immense, because operating circumstances vary so widely; airframe deterioration, for example, is greatly accelerated in steamy tropical climates, and airframe life is influenced substantially by average stage-length.

But, given suitable safeguards, the rewards of such a guarantee are high, and the experiment seems well worth trying. As with the trading-in of second-hand fleets, it may *have* to be adopted where sales are slow.

Entertaining the Public

PUBLIC taste in air displays, as in a good many other kinds of entertainment, is oddly unpredictable. In the course of a good many years of display-going we of *Flight* have more than once seen a typical crowd showing signs of boredom at a full-scale affair with Service support; we have also seen an equally typical assembly displaying obvious enthusiasm over an unassuming little programme offered by a local club. And, of course, the factor of unpredictability must inevitably be multiplied by *x*, the meteorological unknown quantity.

Display organizers deserve sympathy. Their problems are as numerous as the hours of hard work, usually unpaid, which they must put in both before and during the event. Almost as soon as a date is decided the work of detailed organization must begin; and no one who has not experienced it has any idea of the number of snags, likely and unlikely, that are certain to crop up.

There is no golden recipe for success; the unknown factors are likely to intrude even when past experience is available as a guide. But as critics in the stalls (and as occasional performers—as noted on page 235, *Flight's* Gemini was a guest participant in the recent Leinster display) we may presume to offer a few basic suggestions. For instance, individual routines should be agreed with the pilots beforehand, and modified only under the stress of real necessity; timing of each item should be rigidly observed by both performer and Control (as superbly demonstrated at Naval air days); understudies should be standing by to fill any unexpected gaps; pilots lacking display experience should be reminded of the necessity for lining-up their flying in relation to the public enclosures, and of not performing their star evolutions on the far horizon; when humorous items are planned, the planning should be the work of one good man—too often too many people try to contribute, with the result that the genuinely funny moments are separated by flat periods; and, finally, the commentator should have the rare gift of striking a happy medium between the extremes of the facetious and the pontifical. Such, in our view, are the half-dozen primary rules which, duly observed, will help to ensure that air displays continue to hold their present surprisingly strong position as public attractions.

FROM ALL QUARTERS

A British Satellite?

AFTER visiting the Woomera rocket range last week, the Minister of Supply, Mr. Aubrey Jones, referred at Adelaide on August 7 to the possibility that Britain might undertake an artificial-satellite programme using rockets such as Blue Streak and Black Knight (*Flight*, August 1, page 156). He said that the Royal Society was considering whether the "huge expense" of using large rockets to launch satellites would be warranted, and commented that the modification of such rockets would be an expensive diversion from Britain's military effort.

A Ministry of Supply spokesman in London confirmed that talks had been going on between the Ministry and the Royal Society to decide whether the large British rockets could be used for satellite launching.

News of Malkara

ACCOMPANYING Mr. Aubrey Jones (see news item above) was Mr. Athol Townley, Australian Minister of Supply. He gave the first details of the Australian-designed Malkara ground-to-ground anti-tank weapon. Weighing 200 lb, Malkara can be launched from fighting vehicles against tanks, landing craft and concrete emplacements; it is guided by radio (presumably by visual command). Mr. Aubrey Jones announced that Britain has ordered 150 Malkaras, costing about £320,000 Sterling. An additional thirty have been sent to Britain for acceptance trials and further tests will be conducted on a range in Scotland next month.

Comet 4 at New York

DUE to return to Hatfield last Tuesday evening, August 12, after noise tests at New York International Airport, was D.H. Comet 4 G-APDA. It had left Hatfield at 9 a.m. local time last Sunday, arriving in New York—after refuelling at Gander—10½ hr later. The return crossing was expected to be achieved in record time.

Among the 22 people on board the aircraft were a D.H. crew of six; a B.O.A.C. crew of five; seven D.H. executives (including Mr. Frank Lloyd, Mr. Martin Sharp and Dr. D. P. Howlett); three Rolls-Royce executives (including Mr. F. B. Greatrex); and a representative of Marconi. The Comet was commanded by John Cunningham.

The result of the tests, on which depends the inauguration of B.O.A.C. transatlantic Comet 4 services this autumn, may be made known in the next ten days.

Viscount Tragedy

A CENTRAL AFRICAN AIRWAYS' Viscount 748, on a scheduled once-weekly flight from Salisbury to London, crashed in hills six miles south of Benghazi early last Saturday morning, August 9. The accident took place in the course of an approach to Benina. Of 54 persons on board (47 passengers and seven crew) only 15 passengers and three crew survived. With one exception, all the survivors are reported to have been occupying rear seats.

EYES TO THE SKY: Illustrative of the intense interest and enthusiasm which marked the World Parachute Championships at Bratislava is this view of officials, competitors and spectators watching one of the descents. A report by Mr. "Dumbo" Willans appears on page 222.

LIFTER FROM ST. LOUIS: Powered by three AiResearch GTC-85-35 gas-turbine/compressors feeding pressure-jet tip burners, the McDonnell Model 120 flying crane helicopter weighs 2,400 lb empty and can lift 3,900 lb from a pilot-controlled hook. The 120 can fly with one engine out and has a range of 80 miles at full load.

The P.1B Named

IT was announced last week that the Air Council has decided to give the name Lightning to the English Electric P.1B, which is due to go into squadron service with the R.A.F. in the near future. This name was last borne by the wartime American Lockheed P-38 long-range fighter.

Long-haul Voodoos

SEVEN McDonnell F-101A Voodoos flew non-stop from Bergstrom A.F.B. in Texas to R.A.F. Bentwaters, Suffolk, on August 10. They were refuelled twice during their flight of 5,292 miles, which was made at an average speed of 600 m.p.h. One of the pilots was Maj. Adrian Drew, who in December last year set up a world speed record of 1,207.6 m.p.h. in a Voodoo based at Bergstrom.

The seven Voodoos which have flown here are to be used on training missions and will return to the U.S. More are due to come over later to form three British-based squadrons.

Proteus for Land Speed Record

WITH the full agreement and backing of Bristol Aero-Engines, Ltd., the M.o.S. has loaned two Bristol Proteus 705s to Mr. Donald Campbell for use in an attempt on the world land speed record which he is to make at Utah Salt Flats in 1960. Weighing up to 9,000 lb and measuring 30ft 4in long, the vehicle will be powered by one of these engines, which will breathe through a pitot intake in the nose and drive all four wheels through extension shafting. The free-turbine layout dispenses with the need for clutch and variable gearing.

Peak speeds in the region of 500 m.p.h. are expected during two runs along an eleven-mile sand course. Airbrakes mounted near the tail of the vehicle will be used to reduce speed to 400 m.p.h., after which the disc brakes on the driving axles will become effective.

The streamlined body, housing the very large wheels under fairings, is designed to provide a slight negative lift component on the c.g. Engine exhaust, providing some 400 lb thrust, will be vented either through a single aperture above the tail or through four tubes, two venting below and two above the tail. The purpose is to avoid disturbing thrust components and high drag from

"FLIGHT" AND FARNBOROUGH

FOUR greatly enlarged special numbers of *Flight* will be published in connection with the S.B.A.C. Show:—

August 22: "Commonwealth Aircraft Industries". Appearing next Friday and reviewing activities of aircraft, engine and components manufacturers in the countries of the British Commonwealth.

August 29: "Britain's Aircraft Industry". A detailed, specially illustrated review of British aircraft, engines and components, including a directory to the products and services of the ancillary industry.

September 5: "Farnborough Report". A first-hand report on the aircraft and flying demonstrations at the opening of the show.

September 12: "Farnborough Review". The rest of the show-week news and pictures together with a further survey of technical innovations. Regular features will appear in this and the other Farnborough numbers.

Demand for these special issues is always heavy, so advance orders to newsagents are strongly advised. The very big August 29 issue will be on sale at 2s. 6d., the others at the normal price of 1s. 6d.

turbulent wakes. Some 5,000 effective horsepower may be achieved at full speed by the Proteus installation.

Wind-tunnel work in the aeronautical department of the University of London has now been completed, with the assistance of Prof. H. B. Squire, Professor of Aeronautics. The design and construction are the responsibility of Norris Brothers, Ltd.

More Emphasis on Decca

JUST published by the M.T.C.A. is a civil aviation information circular which restates the United Kingdom's policy on short range navigation aids. The circular summarizes air traffic control requirements as follows: (1) The maximum utilization of controlled air space must be achieved; (2) A high-capacity route structure must be provided; (3) Aircraft must be given the greatest possible freedom in the vertical plane.

Remarking that VOR, NDB, radio range and similar systems cannot provide the necessary facilities (though a limited number of VOR beacons are being installed along the airways), the report unequivocally states: "Extensive flying experience over the past six years in many types of aircraft has clearly demonstrated that the Decca Navigator system best meets the [above] requirements.

"It provides," the circular continues, "vastly improved means for navigating all types of aircraft in the departure, en route, holding, descent and approach phases of flight."

Noting that the combination of Decca and Dectra as tested on the North Atlantic route gives a comprehensive navigational system using one airborne receiver, the report states that the M.T.C.A. intend to introduce new Decca procedures, including special climb-out routes in the London F.I.R. And, in so many words, the report implies that airliners equipped with Decca will be much better off from the A.T.C. point of view than those not so equipped.

Edgar Percival Aircraft

WHEN the first meeting of creditors of Edgar Percival Aircraft, Ltd., was held in London on August 6 the creditors were told by Mr. H. G. Gill, Assistant Official Receiver, that there was an estimated total deficiency of £318,975 as regarded creditors and shareholders. A draft statement of affairs disclosed unsecured liabilities of £394,767, of which £344,326 was due to the Finance Corporation for Industry. In addition there were preferential debts of £3,786. Assets were estimated to realize £104,578.

LIMBERING UP for Farnborough: Sea Hawks of No. 800 Sqn., which with Scimitars of No. 803 are this year's R.N. representatives at the S.B.A.C. Show, practising their formation aerobatic routine from R.N.A.S. Brawdy, the squadron's shore base. *(See also page 243.)*

"Flight" photographs

In the Year of the Fighters

THINGS SEEN ON A VISIT TO EDWARDS AIR FORCE BASE

By Robert D. Archer, A.R.Ae.S.

ALTHOUGH it was only 6 a.m. the sun shone exceedingly brightly through the clear desert air. We were on our way to Edwards Air Force Base, California, open to the public once again on the occasion of its annual "open house." On we drove across the desert, passing the dry lakes used for parachute supply-drop tests, and thinking what a deadly place in which to get a flat tyre—it was 18 miles from the guardhouse to the air-base control tower.

Arriving at the base centre, we parked, gathered our photographic equipment and set forth. It was now 8.30 a.m. and there were as yet but a handful of people around the 40-odd aircraft standing in two neat rows facing one another on the tarmac. In the background the huge hangar next to the control tower was already open, offering displays of aircraft, engines and equipment.

The first thing to be noticed inside the hangar door was a full-size replica of *Explorer*, America's first satellite, looking very slim and small. Next to catch the eye was the Northrop T-38 (supersonic trainer) front fuselage and cockpits mounted on its rocket-propelled sled for high speed ejection tests. Facing it—and bearing a striking resemblance in overall shape—was the nose of the high and mighty Convair YB/RB-58A, the Hustler, which was the fifth machine about to begin its tests at this Air Force flight-test centre; and nearby stood an example of the Lockheed F-104A Starfighter which had just become the holder of the world's air speed record at 1,404 m.p.h. and of the altitude record to boot.

We looked at small displays by Convair, Hughes and North American Aviation; paused in front of an F-100 with an assortment of stores around it; jumped as a small single-barrel rocket motor was fired; and studied with interest at a miniature track along which scale models of actual sled-test vehicles were fired, to be halted by a water brake at the end of a 60-foot run. Engines on display included the Pratt and Whitney J57 and J75 and the Wright J65. Sunday film shows, photographic-laboratory demonstrations and display stands by the N.A.C.A. completed the round-up of the hangar, together with the inevitable hot dog and Coca-Cola stands.

In the ranks outside I noticed first the Army's Sikorsky H-37A Mojave (with its huge clam-shell nose doors wide open) and, looking exceedingly tiny next to it, a Hiller YH-32 Hornet, flanked by a Cessna YH-41. The Douglas D.558-2 Skyrocket was still wearing N.A.C.A. colours, as was its partner, the Bell X-1E, which had new additions in the form of ventral fins (like those on the Chance Vought F8U-2)—and, painted on its nose, the name *Little Joe*.

Striking in its paint scheme of grey and vivid red was the North American XF-107A—since dropped in favour of the F-105—the most striking feature of which is its enormous variable intake above the cockpit. The Convair F-106A looked as though somebody had splashed a can of fluorescent red paint over it. No bulges on this debugged, faster version of the F-102; and the cut-back intakes showed a movable entry hinged at the forward end.

The prototype Republic F-105B Thunderchief—looking stilty on its long landing-gear—displayed its many unusual features, from the swept-forward intakes to the petal-type air brakes at the end of the fuselage. Low on the ground by contrast, a long and lethal-looking F-104A revealed an interesting modification to its intakes, consisting of the addition of a fan-type screen. The aircraft bore the name *Slasher*.

Passing the two-seat F-104B and the McDonnell JF-101A reconnaissance Voodoo, which displayed some additional dielectric panels on the nose, we came to the trusty North American F-100F and F-100C—the first of the "Century series" and still in production—then stopped to look at the only remaining example of the TF-86F, the two-seat trainer version of the Sabre, of which two were built. Other aircraft in the front rank of the line-up included an F-86H, one of the standard "chase planes" at the base; an unusual Thunderstreak, designated NF-84F, with a Curtiss-Wright thrust reverser (shown in the reversed position) at the rear end of the jet-pipe; the Merlin-powered F-51D Mustang used by the N.A.C.A. and having modifications to one-third of the wing panel, for testing different types of aerofoil; and several examples of current production fighters such as the Chance Vought F8U, Grumman F11F, and Douglas F4D, and A4D-2, which now has a long refuelling probe on its starboard side.

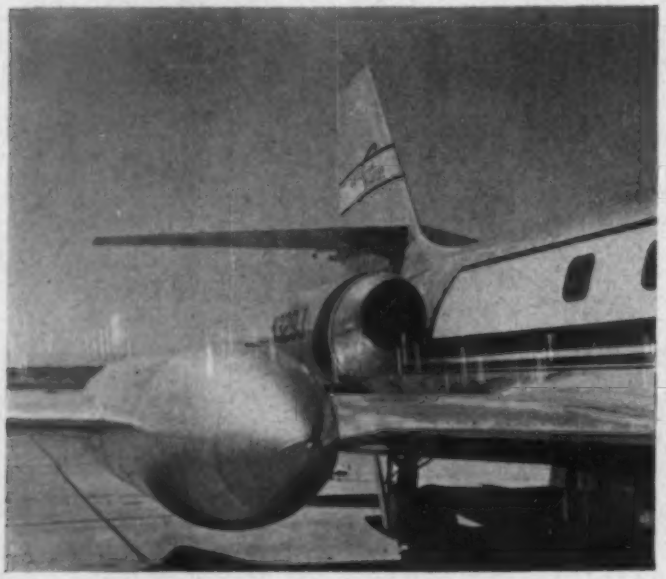
Suddenly halted by the sound of powerful turbojets being run up, we saw that four F-100s and four F-104s were preparing to take off for a reminder fly-past over neighbouring towns. The General Electric J79 in the F-104 runs at constant, high r.p.m., and has a very high-pitched note, quite unlike that of any other engine I have heard in England or the U.S.A. The F-104's take-off was exceedingly rapid and the climb likewise.

Turning now to the really big aircraft, one found that the hulking Boeing KC-135A looked even bigger than it does in photographs—and even though it was flanked by the biggest American aircraft in production, the Douglas C-133A Cargomaster, painted in arctic-area colours.

I blinked at the next aeroplane, for in such company it looked

(Right) The Republic F-105A Thunderchief has petal-type air brakes surrounding the huge orifice to the Pratt and Whitney J75 (24,500 lb reheat thrust.)

(Below) With two of these 300 U.S.-gallon additional tanks the Lockheed Jetstar can fly 2,280 miles; later 640-gal tanks will be fitted. Engines are TJ-37 Orpheus.



Much faster than the earlier F-102 Delta Dagger, the Convair F-106A Delta Dart has variable-geometry intakes to its 25,000 lb-thrust J75.

(Right) One of the curious features of the North American F-107 is its slab-type single vertical tail surface, which provides excellent control up to Mach 2.2.

out of place: a Boeing B-17G, civil registered N6694C. Actually it was one of the five-engined Fortress variants used for flight-testing new engines; and this one had a Wright Turbo-Compound in the nose, driving a four-bladed propeller. The next machine of interest was a Fairchild C-123J Provider with its retractable skis and wing-tip mounted turbojets with movable shutter intakes; and close by was a very ordinary looking C-54 which, however, had the odd designation of JZC-54A and is used for special tests.

Passing the familiar B-57, B-47 and B-66, we came to the Lockheed 329 Jetstar N329, sporting something hitherto unseen: two enormous glove-type wing tanks at approximately half span. These are slid on over the wing from the tip (according to the Lockheed representative from Marietta, Georgia, where any production models will be built, installation taking about two hours.

Having now come to the end of the lines of aircraft, and as it was getting exceedingly hot, we were glad to sit in the shade and await the flying display. It started, at 1.15 p.m. precisely, with a sonic boom by an F-100 from 30,000ft. Conditions could not have been better: there was not a cloud in the sky, the snow-capped 10,000ft summit of Mount Antonio ("Old Baldy") was clearly visible 45 miles away.

For the demonstration the aircraft took off in order, flew away and then made one pass each from east to west down the main runway. First was the Cessna T-37 twin-jet trainer, which made an interesting contrast to the C-130 that followed it, and to the vast C-133. A B-57 flew by—the commentator acknowledging its English (Electric) descent—followed by a B-66 (smoking heavily), afterwards by three F-86s in close formation; and then a lone F-84F. But this was the year of the Century fighters, and they dominated the day above all: thundering past in rapid succession came the F-100, F-101, F-102, F104, F-105 and F-106, the last-named showing up strikingly against the blue sky in its fluorescent red. (The C.A.A. has recommended that all aircraft now flying should have at least one-third of their area painted in this colour as an aid to collision avoidance—a subject causing much heated discussion in the States these days.)

Following came the Navy quartet, the A4D, F4D, F8U-1 and the F11F-1F, the 1F being the second example of the Super-Tiger and now employed by General Electric for development work. When all the fly-bys had been completed the aircraft landed and taxied close in front of the crowd, so that everybody had a really near view. Coming somewhat as an anti-climax, but nevertheless an instructive one, was the display drop by a C-119 of a heavy cargo supported by three parachutes manufactured by Radioplane. This was followed by a demonstration by a Vertol H-21 helicopter; then there was a brief period of peace and quiet, soon shattered by the fly-past in tight formation of thirty-two F-100s from George Air Force Base. This ended the day.

As I left, to drive once more across the desert, I reflected on the incredible advances from the Mustang to the F-104, and on what I might see here next year. But one thing was certain—this was the fighters' year, and Mach 2 fighters at that.

LEE'S AIR DAY

THOUGH dogged by this year's deplorable summer weather, which curtailed the flying programme, H.M.S. *Dædalus* nevertheless put on a comprehensive and entertaining display of Naval aviation for the 15,000-odd visitors who came aboard at Lee-on-Solent last Saturday. What was to have been the crowning item, formation aerobatics by seven Sea Hawks of No. 800 Sqn., did not materialize; the aircraft were grounded by low cloud at their home base, Brawdy, and could not appear at either Lee-on-Solent or Yeovilton. But visitors to Lee at least saw the Royal Navy's latest aerial equipment. For despite the poor conditions a Scimitar (flown by Lt-Cdr. D. Norman) came over from Boscombe Down, doing steep turns at an incredibly low altitude and during them disappearing alarmingly into cloud; and the masterly Jock Elliot brought a Sea Vixen from Christchurch, showing just how controllable this aircraft can be when flown a few feet off deck level with everything down and out. The R.A.F. were also represented, in the impressive shape of a Vulcan from Waddington.

No Naval Air Day nowadays is ever complete without a liberal sprinkling of helicopters and Lee showed off these ubiquitous machines in full measure. As an overture to the afternoon's proceedings a Swordfish led on-stage three Hillers, three Dragonflies, nine Whirlwinds and a Wessex, flying in wide but impeccable formation; and the display, though curtailed, was admirably punctuated by skilful demonstrations of rotary-wing flying. "Slim" Sear, now of Westland's but formerly of the Royal Navy, put the Wessex expertly through its agile repertoire; Lt-Cdr. Spreadbury showed just how crazily a Hiller can act in the hands of an ostensibly inexperienced pilot; J. G. P. Morton of Faireys (also ex-R.N.) put the Ultra-Light down on a lorry with fairylike lightness; two Dragonflies demonstrated A.S.R. and the airworthiness of an Oriental magic carpet; and four Whirlwinds dropping Army parachutists showed how useful a piece of equipment the helicopter is for this purpose.

Civilian parachutists, from the Plymouth Parachute Group, also jumped at Lee (from an Auster) and it was to one of these hardy enthusiasts that the afternoon's only untoward incident occurred. By an unfortunate mischance he missed the airfield and arrived on a local greenhouse, fortunately not sustaining serious injury. He was at any rate well enough to attend a cocktail party in the wardroom of H.M.S. *Dædalus* afterwards, though heavily bandaged around the head and wearing one of the ripest black eyes one has seen for some time.

Apart from the air display (in which a Turbulent also delicately participated), and pleasure flying both before and after the programme, Lee's Air Day included static exhibits showing all sides of Naval aviation activities. An especially popular item was the "abandon ship" drill; guided weapons were on view, radio equipment, armament, and models of aircraft carriers. No doubt all those who attended (for the benefit of Naval charities) thoroughly enjoyed their afternoon; and the station, which is commanded by Capt. A. F. Black, had obviously gone to the utmost trouble to make all arrangements as satisfying as possible. The only thing which could not be arranged was the weather, which by the end of the flying display (around 4 p.m.) had improved considerably. The same thing happened at Lee the previous year; and it might be worthwhile next time to start the flying a little later in the afternoon, say at four o'clock. At least it would be worth trying, to outwit for once our notoriously unreliable summer climate. H.W.

World Parachute Championships

TOUGH TASK FOR THE BRITISH TEAM

Left, Sue Burges, with the blank-gore canopy, in the spot-landing contest after a 2 km glide. Right, Reilly (Britain), Tomkins (U.S.A.) and Miss Burges (Britain).

Bratislava, Czechoslovakia.

THE decision to send a British team to the Fourth World Parachuting Championships was made at very short notice, although the question had been under discussion for some time. There were two schools of thought among parachutists—the first suggesting that it would be wiser to wait until there were British performers who were well enough trained really to stand a chance of winning, and the second stating very firmly that the best way to learn parachuting was to get some of our people among the champions as quickly as possible. They would then be able to pass on the experience they had gained. There was a good deal to be said in favour of both these alternatives, but the pressure from those who wanted to "have a bash" was so strong that they finally had their way.

The parachutes available to the British team were of two types. Denis Lee and James McLoughlin each had an Irvin 28ft trainer main and reserve, while Sue Burges and Mike Reilly had G.Q. blank-gore steerable outfits. Two more blank-gore mains were loaned by the British Parachute Club as spares to be shared by the team.

Lee and McLoughlin decided to travel to Bratislava by train, and took with them four of the six parachutes in order to relieve the other two team-members, who were making the journey by air, of very considerable excess baggage costs. The arrival day in Bratislava for contestants was August 1; but, finding it impossible to book seats for that day, Burges and Reilly decided to fly out on July 31. John Fricker, the team pilot, was the only member who had been able to book a flight to Prague on the correct day, and so a long and carefully worded telegram was sent to the Aero Club of Czechoslovakia explaining the scattered arrival of the British competitors. The telegram never reached its destination, and the result was chaos.

At a meeting of the F.A.I. parachuting committee in Paris, the Czechoslovak representative had suggested that visiting teams should arrive via Prague, where they would be directed into the right channels. Acting on this advice, Miss Burges and Reilly, accompanied by the writer, stepped hopefully off the Viscount at Prague Airport and waited for further instructions. It was only when all the other passengers had left the building that it was discovered that no one there had heard of the World Parachuting Championships—nor, apparently, the Aero Club of Czechoslovakia.

At last, after an hour or so of frantic activity, the telephone number of the Aero Club was discovered, and the English-speaking airline reception girl began to smile again. We were instructed to book to Bratislava on the domestic airline, and after a five o'clock snack of beef and dumplings in the blazing sunshine, we took off in an Il-14.

Unexpected Guests

We stepped out of the aircraft at Bratislava into what felt like a North African summer and, skirting a large group of children in national dress, made our way round to the front of the small terminal building. On the way round I shook hands with a member of the Czech parachute team who I had met in Russia two years ago. He seemed surprised to see us, but as we had no common language I had no way of finding out exactly what he was puzzled about. It was not until much later that I discovered that our arrival was completely unexpected, and that we had inadvertently gate-crashed a reception laid on for the Russian team. Our hosts saved the situation by detaching three charming girls from the gathering, who presented us with bunches of flowers. This pleasant gesture was made in such a way that we were at the time quite unaware of the slight embarrassment that our arrival must have caused.

From here on the organization worked without a hitch, and within half an hour we were comfortably installed in the Mlada Garda (Young Guard) student's hostel.

On the morning of August 1—the day scheduled for arrivals—it was announced that teams already present would be allowed to start on the two practice jumps allowed in the competition rules, and "Burgesova"—she was described thus in the list of competitors—and Mike Reilly decided to get to work. The American team, led by Jacques Istel and smartly equipped in identical black flying suits and identical crew-cuts, were already on Vainory Airfield; and as Fricker, Lee and McLoughlin had not yet arrived, they offered Burgesova and Reilly seats in their An-2. These aircraft, in Russian, Czech and Hungarian markings, were each equipped with their own pilot, who normally handed over control to the team pilot once the machine was airborne.

When the Americans began their practice jumps, it soon became obvious that they, too, had realized the value in competition of the steerable canopy. This type of parachute—used for the first time in competition in the Third World Championship four years ago—has now been copied and modified by almost every country interested in sporting parachuting.

In the American version the gore normally missing has not been completely removed, and the top (D) panel had been left in position. This, it is claimed, gives increased drift. Directional control by guide rings remains standard. In addition to this, the parachute is fitted with slip-risers, a device for tilting the whole canopy forward and so increasing the drift. The effect of the open gore—situated behind the parachute—assisted by full forward tilt is spectacular.

Sue Burges and Mike Reilly, used to a parachute-opening height of 1,500ft, found it difficult to reach the scoring area after a glide from more than 3,000ft. Parachutists—men and women—from Russia, Bulgaria, Hungary, Poland and Yugoslavia were landing short distances from the centre of the circle with almost monotonous regularity, and it was fast becoming obvious that the West was going to have a hard battle to compete with the highly trained teams from the East.

When Fricker, and parachutists Lee and McLoughlin, arrived from England in time to complete the two practice jumps it became apparent that our whole team—though enthusiastic to bursting point—were going to suffer from lack of experience. Lee and McLoughlin were particularly handicapped—as were the French team—by their non-steerable parachutes. So, with the consoling thought that if they stood small chance of winning, at least they were going to learn a great deal, the British team turned out for the opening ceremony.

Unbelievable Aerobatics

It rained. In front of the stands with their sodden but still impressive array of flags, teams from twelve countries stood through the opening ceremony, soaking up water like sponges. A huge crowd of spectators had already been there for five hours.

There were opening speeches by President of the Czechoslovak Aero Club, Karel Grepl, the Commissar for transport Karol Fajnor, and Mr. Gillman of the F.A.I., and then, still in pouring rain, the opening air display began. There were 24 items in the programme, and certainly more than half of these took place at altitudes of from three or four hundred feet downwards. To summarize—and there is not space enough to do more—nearly every aircraft present, singly and in formations, whether flown by girls of eighteen or pilots of world championship class like Vilem Krysta, did every aerobatic manœuvre in the book. Those who were fortunate enough to see Krysta perform at Coventry will have an idea of just what this means.

One example from an afternoon of the world's best flying was casually dismissed in the Press handout in the following words: "Then followed pilots Jaroslav Hudec and Frantisek Novak from Brno, with a display on a motor propelled plane of the type Trener Z 226, trailing a glider VT 7." Let it be recorded for posterity that these two machines, *while still on tow*, rolled individually and together, flew inverted, and together, did loops, *outside loops*, and *outside turns*.

The parachuting contribution consisted of long free falls with smoke trailers, in pairs and groups, with individuals changing position during the fall. In a mass drop from three C-47s, a freak wind carried about sixty parachutists off the field and out behind the crowd, and then at the last moment brought them all the way back to land in the correct place.

The championships began on Monday, August 4, in fine weather. The first leg of the competition consisted of two precision-drops from 1,000 m with immediate parachute-opening, and the Americans drew the difficult No. 1 position. After a dummy had been dropped as drifter, team captain Istel made the first jump and landed 5.66 m from the centre of the cross. His team-mate, Tomkins, copied the Russian technique of landing sitting down with feet towards the target to record 36.57 m, but, unlike the Russians, he did not wear a cushion on his posterior. It was noble, but it must have hurt. The best jump in the first round was Sarkov of Bulgaria with 0.21 m. Of the British team, Reilly came nearest to the centre at 146.38 m. Lee got to 146.82 m and McLoughlin and Miss Burges failed to reach the scoring area.

In the second round of the first exercise Sue drove in from more than two kilometres away to land at 54.66 m, followed by Reilly at 16.83. The three leaders (men) at the end of the first exercise were Vodenicarov of Bulgaria, 6.93 and 1.97 metres; Gyulai, Hungary, 5.64 and 5.33; and Dmitrov, U.S.S.R., 4.94 and 10.09. The first woman was Skopinova of U.S.S.R. with 7.87 and 1.67.

Event 3 has been run ahead of Event 2 because of ideal weather conditions. This is an individual jump from an altitude of 2,500 m with 35-43 sec free fall, execution of aerobatic figures in free fall and marking for style. The official results are not yet available but it is apparent that though the British team still have a lot to learn about this exercise they have put up a very creditable performance, with coaching from the Russians and Americans. The exercise is proving very much worth while.

T. W. WILLANS

Stop Press: Fine weather, and the determination of the organizers to finish the championships as quickly as possible, brought the competition to an end last Sunday. It had originally been intended to continue jumping well into this week. Not unexpectedly, the U.S.S.R. won all four titles. The individual championship for men was won by Piotr Ostrovsky, and for women by Miss Nadazda Priachina, while Russians also won the team events for men and women. Further comments by Mr. Willans will appear next week.

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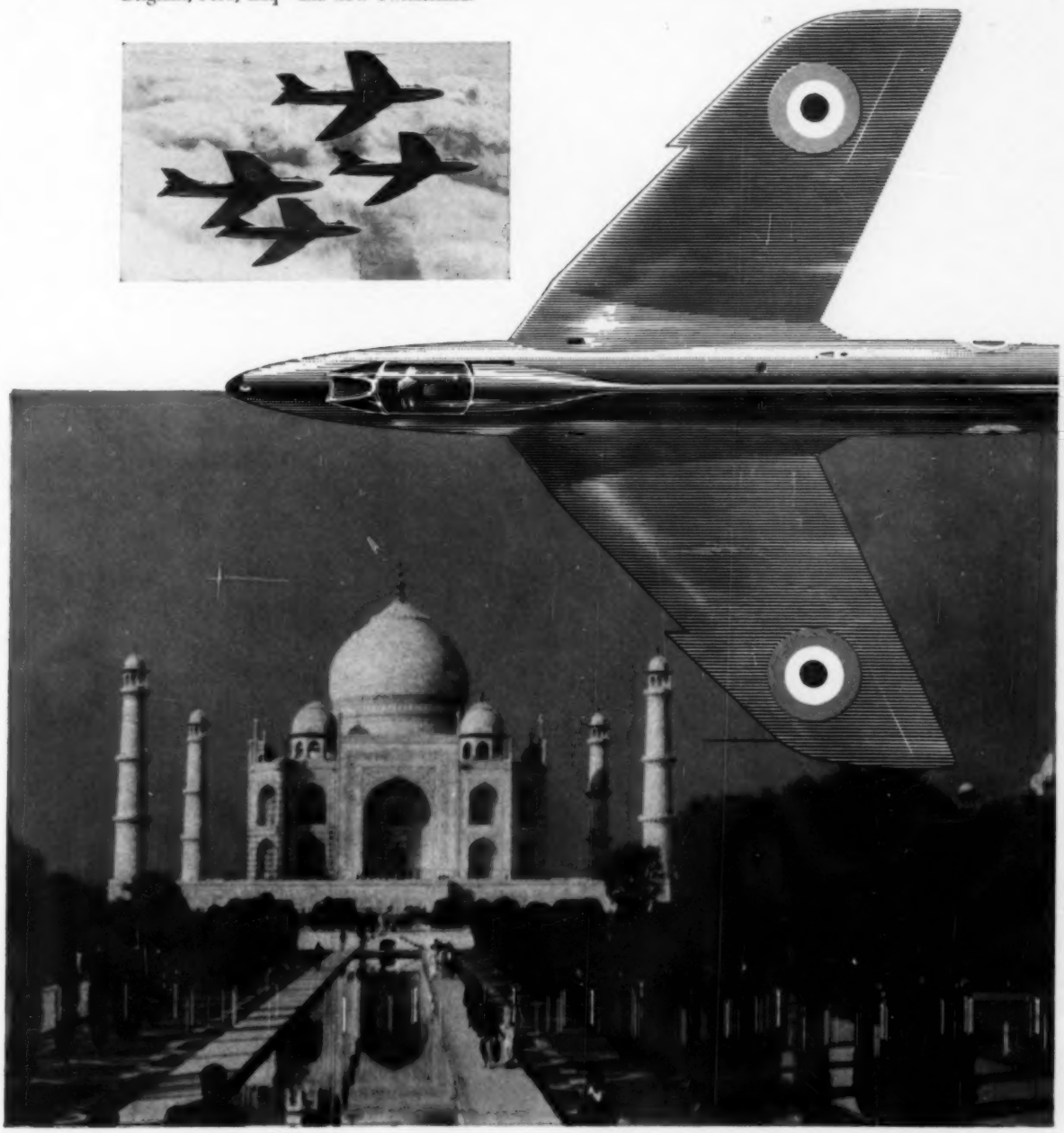

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Law of Space: What Next?

By JAMES AVERY JOYCE, Ph.D., B.Sc. (London), Ll.B., F.R.G.S.

Geneva, Switzerland.

TWO earlier articles* in *Flight* raise several practical questions with regard to what has become known as "The Law of Space"—questions which, as one of the writers, Mr. Aaronson, points out, are "not yet covered by the existing rules of international law." Both these articles appear to the present writer to have adequately filled in the background to the problem by stressing the limitations of present-day international law and calling for the creation of a new kind of supra-national law.

Mr. Caplan, in particular, does not mince words in describing "the terrifying principle" of national sovereignty as "a dangerous disease of the mind when it is used to stifle individual liberty of thought or when it is used to project nationality from the surface of the earth up into space itself."

This point could hardly have been better made. It must be remarked, however, that the United Nations' Law of the Sea Conference, which has recently concluded its important sessions here in Geneva, has given a sad warning (even if its positive results have exceeded the expectations of most lawyers) that any Law of Space conference—now urged in several authoritative quarters—will have to deal with this same "dangerous disease" in its most virulent form.

Michael Aaronson enforces this warning when he calls attention to Von Braun's projected space station and reminds us that "in order to obtain the enormous public funds required for this project, it has been justified as an invulnerable bombing platform that will enable the United States to maintain world peace . . . Atomic missiles would then be launched from the space station on to relevant Earth targets." Very reassuring, no doubt; but, alas, Mr. Aaronson goes on to tell us: "Soviet scientists are reported to be working on similar projects"! This sombre commentary on our twentieth-century civilization sounds very much like John Galsworthy's tragedy of the Greek-Trojan War, $X=0$, and leaves us with the foreboding that the "dangerous disease" has already gained a long start on any future space-law.

For that reason, men of science—the practical men who actually put the aircraft and rockets into the air, and beyond the air—will have to work fast and hand-in-glove with the men of law in devising a space code which will be both scientific and sane and not a projection of Earth's politically diseased minds into a realm where medieval concepts of national sovereignty can have no earthly meaning.

The close relations of law and science could not have been better expressed than by U.N.'s Legal Counsel, Dr. Stravropolos, when he told the Law of the Sea Conference:—

> "This is a dynamic age. The rapid advances of modern science, the changing patterns of the economic and political structure of the nations which combine to form our international society, call for a legal system which is capable of adaptation to meet the requirements of international society. This is, of course, not a problem unique to international law. Every State faces the need to adjust and apply its municipal law to the changing interests of its society and to solve the conflicts of interests which necessarily arise and which it is the task of the law to settle."

Need for a Code

In order to carry the debate a stage further, it will be helpful to examine briefly the "possibilities" which both Mr. Aaronson and Mr. Caplan outline at the end of their stimulating articles, and, at the same time, to put forward one or two tentative suggestions as to the actual procedure which might be followed on the international level during the coming months.

The urgent necessity of constructive proposals along some such lines need hardly be stressed. In the March issue of the U.S. magazine *Air Force*, Brig-Gen. Homer A. Boushey, an expert on aerial research, is quoted as advocating the value of the Moon for strategic purposes; the article continues:—

> "The Moon's high ground could, General Boushey suggests, serve as a launching point toward Earth for retaliatory missiles, with only about 20 per cent of the thrust needed on Earth. These missiles could —thanks to the lack of resistant atmosphere—be launched from shafts sunk into the Moon's surface, perhaps even catapulted, with no internal propellant. Once a missile was launched Earthward, the Moon-based crew could track and guide it."

The *New York Times* (March 24, 1958), in commenting on these views, states: "It is discouraging to read of these exciting prospects, which may soon enable man to contemplate how minute is his being in this universe and then to realize how apparently intent he is on suicide." The newspaper goes on to hope that "if the summit meeting does indeed occur, it will commence to systematize exploration of space."

But in view of the manner in which the space issue has already been dealt with, in certain parts of the world, as a promising new arena for Cold War strategy, it can safely be asserted that a conference primarily of politicians, one dominated by military considerations, is about the worst possible start that could be made for the peaceful ordering of outer space. As Mr. Caplan so wisely points out: "The machinery which drew up plans for the I.G.Y. should be used without delay to draw up a code of conduct for human activities in space"; and, he adds, "the evolution of a code should be entirely the work of scientists, assisted by international lawyers for drafting purposes only."

It will be recalled that the International Astronautical Federation, at its meeting in Barcelona last year, decided that a committee of leading scientists should be set up to prepare a list of recommendations for laws to govern outer space. The chairman of this committee is Prof. John Cobb Cooper, legal adviser to the International Air Transport Association. Legal representatives from the British Interplanetary Society, the American Rocket Society, the Deutsche Gesellschaft für Raketentechnik und Raumfahrt, and from Soviet Russia, were invited to serve on the committee. It is understood, however, that the Russians have not yet accepted the invitation to join it, as they themselves urged action through the machinery of the U.N. General Assembly. If the committee does meet, their recommendations would be submitted to the United Nations.

Preparing the Ground

Meantime, Sir Leslie Munro, the distinguished New Zealand lawyer, who was president of the last General Assembly of the United Nations, has proposed that the next regular Session should get down to the urgent task of authorizing the drafting of such a code; and Secretary-General Dag Hammarskjold, at a recent news-conference in New York, gave the hint that behind the scenes U.N. lawyers were preparing the ground for what may be one of the most vital decisions of our present Year of Space—whether, and how, to create U.N. Sovereignty over outer space.

A major debate on what is to be done with space will therefore almost certainly take place at the Thirteenth General Assembly, which will open in New York in mid-September. There seems to be a growing consensus of opinion, too, that some kind of United Nations agency is the indispensable instrument, from all points of view, for tackling this, literally, superhuman task.

Nor should it be forgotten that, before the first Russian satellite appeared, Mr. Harold Stassen put forward at the Disarmament Sub-Committee, meeting in London last summer, a tentative plan for the control of missiles designed to travel in outer space. The U.S. spokesman emphasized that an uncontrolled race into outer space for military purposes held dangers for *all* States. Even without a full disarmament agreement, he said, it was essential to tackle this new problem on its merits. He proposed, therefore, the establishment of a technical committee to outline an inspection system which could assure that the sending of objects to outer space should be *exclusively for peaceful and scientific purposes*.

In fact, many national leaders have been thinking along the same lines on both sides of the Atlantic. Senator Lyndon B. Johnson, United States Senate majority leader, proposed recently that his own Government, *acting through the United Nations*, should invite all member nations to pool their resources, talents and ideas for the conquest of outer space. He said: "The dimensions of space dwarf our national differences on Earth. If we are to win space as the outpost of peace, all men may and should share in that endeavour."

The Canadian Prime Minister, Mr. Diefenbaker, another outstanding lawyer, has also strongly expressed the view that an international agency, *vesting jurisdiction of the atmosphere in the United Nations*, should be established. He has urged that all nations, however weak, should have the same territorial rights in space, and that space above 300 miles should be open to all "craft."

On this last point, incidentally, it is to be noted that Mr. P. K. Roy, of the staff of I.C.A.O., told a meeting of the International Aviation Writers' Association in Washington, D.C., recently, that "Sovereignty stops at that height beyond which aerodynamically supported machines cannot be operated. That means up to our assumed maximum height of around 50 miles." This same principle was upheld by Professor J. C. Cooper in his address to the International Law Association (*Flight*, December 6, 1957), when he suggested that history would demonstrate that air space and national sovereignty extended to the height at which the density of the atmosphere failed to support flight; and, therefore, it seemed clear that outer space was beyond the sovereignty of any State.

*"*The Law of Space," by Michael Aaronson, December 6, 1957; "The Law of Mediæval Space," by Harold Caplan, D.C.Ae., A.M.I.Mech.E., A.F.R.Ae.S., March 28, 1958.*

LAW OF SPACE: WHAT NEXT? . . .

What is becoming plain to ordinary people is that nothing could be more dangerous—or more stupid—than that two or three major governments, among the hundred-odd sovereign States which at present share the land surface of this tiny Earth between them, should have the effrontery to start outbidding each other in a "race for the Moon" in order to see who could first stick their national flags in it.

In any case, if the assumption in such minds is that the surface of the Moon—or Mars or Venus, for that matter—is subject to the same rules of law which apply to newly-discovered lands on this planet, they should not expect much backing from the lawyers. International law maintains today that mere "discovery" is not sufficient to justify "possession." There must also be human occupation and permanent settlement—which means bringing some of your population to inhabit and develop the territory. The first men to set foot on the Moon can erect their national flags thereon, if they are so Earth-conditioned; but they cannot *legally* claim the whole Moon, or even a tiny portion of it, as "theirs" for keeps!.

Mr. Aaronson makes the valid point that "any development of law in the atmosphere or beyond must be by international agreement."

It so happens, too, that the Cold Warriors (who can usually find reasons for inaction on the part of the West because of what the Russians are doing, or not doing) are outmoded in this instance; for the Soviet Union—already well ahead in the technical field—has taken the political initiative and put forward specific proposals in line with the Western individual authorities we have cited. Unfortunately, however, it seems that the U.S.S.R. has linked her proposals at the present stage to the miserable and sterile controversy about European bases and the whole ICBM conundrum.

If some sort of severance can eventually be made, or accommodation arrived at with the West over the bases (which Russia asserts are just as menacing as Von Braun's atomic space-station), no one can deny that the Russian proposals are much to the point and should be taken on their merits. The relative clauses, published on March 15 this year, are:—

The establishment of a United Nations agency for international co-operation in the study of cosmic space which could have the following functions:

To work out an agreed international programme for launching intercontinental and space rockets, with the aim of studying cosmic space and supervise the implementation of this programme.

To continue on a permanent basis the research in cosmic space, now being carried on within the framework of the International Geophysical Year.

To serve as a world centre for the collection, mutual exchange, and dissemination of information on space research.

To co-ordinate national research programmes for the study of cosmic space and render all-round assistance and help towards their realization.

In addition, the Soviet Government has officially submitted the basic question of space control as an agenda item for consideration at the 13th General Assembly. It is clear, therefore, that a number of highly significant proposals will converge on this autumn's meeting in New York.

Promising Augury?

Having been present at many General Assembly sessions, the writer has had the gratifying experience of discovering that the violent divergences of the big Powers are frequently moderated or lessened by the presence of the so-called "middle" Powers (such as Canada and India) and the smaller Powers (especially the influential Latin-American group), with the result that quite astonishing agreements sometimes emerge from the Assembly. This happened, for instance, two years ago with the establishment of the International Atomic Energy Agency†—whose very success and smooth running is evidenced by the lack of publicity which I.A.E.A. receives in the general Press.

The vital thing is to separate the military from the peaceful projects. Both I.C.A.O. and the I.G.Y., as well as I.A.E.A.—the latter the outcome of President Eisenhower's splendid "Atoms for Peace" project—provide excellent precedents for a "Space for Peace" programme which will capture the public imagination.

Moreover, just preceding the Assembly in September, the Second World Conference of Atomic Scientists will be held here in Geneva when, undoubtedly, a strong body of "non-political" and technical opinion will set the stage, as it were, for the subsequent space debates in New York. Like the I.G.Y., these recurring conferences of the atomic scientists have done much to break the East-West military deadlock. Mr. Caplan makes a valuable point: "It has needed no legislation to make I.G.Y. possible. It may well need none to move safely and peacefully in space."

Mr. Caplan's concrete proposal for an international conference to draw up, in the first place, a universal multilateral convention to fix an upper altitude-limit for national sovereignty and, in the second place, to prepare a code for "the human occupation and use of the planets," is undoubtedly a sound one; but the (unofficial) view in United Nations legal circles at present would seem to be: "Don't tackle the sovereignty problem first, because—as the Law of the Sea Conference showed—national delegations are far too touchy over their sovereignty."

What is needed, therefore, in the months ahead, is a studied attempt to lift this problem away from the military and strategic influences which threaten to monopolize it, and concentrate the combined legal and scientific talent of our time on devising a viable international instrument which will best serve the cause of humanity as a whole. Both Mr. Aaronson and Mr. Caplan would appear to join the present writer in advocating a supranational authority which would, from the start, be empowered to rule out these ridiculous and pretended "claims" of "possession" over the nothingness which we call space.

As Dr. Bin Cheng points out,‡ there is *no alternative* to an international agreement on outer space and to the "creation of a new regime." Although a World Technical Conference in 1959, following close on the U.N. Assembly debates, might give scope to the same kind of nationalistic selfishness and shortsightedness which marred the Law of the Sea discussions, it would unquestionably appeal to the public imagination and subject to the light of day the dangerous claims of any "diseased minds" who (to change the metaphor) at present pull the strings behind Government appropriations and who can only conceive of outer space as mankind's last battlefield.

Polar Precedent

For the British, be it said, the principle involved is not a new one, nor is it germane only to space. Over 50 British M.P.s, representing all the major parties in Britain, went on record a few years back, proposing an international regime of U.N. sovereignty over the polar ice-caps. The high seas, they told the Secretary of State, Mr. Selwyn Lloyd, should also be brought under U.N. control. They appropriately code-named their plan "Neptuno." The Government of India has just requested the U.N. Secretary-General to include on the 13th Session agenda a proposal for "internationalizing" the Continent of Antarctica.

Other examples could be cited of authoritative individual and group opinion moving in this direction of creating a U.N. sovereignty over those parts of the Earth's surface which are *res nullius*. A French scholar, Guy Marchand, for instance, has made the interesting suggestion that all space travel should be placed under the control of the U.N. and that the "new regime" should be named "Etheruno" (in French) or "Unether" (in English).

Now that Russia has come out openly for the same principle, no time should be lost in working out ways and means. A first step would seem to be the convening by the U.N., following the Assembly debates, of a World Technical Conference (not a political one), along the lines of the very successful 1955 Atomic Scientists' Conference at Geneva, looking towards the establishment of an International Space Agency in the near future. The general structure of the International Atomic Energy Agency might be taken as a close parallel.

The proposed U.N. Space Agency would both fix the upper extension of air law and complement the rules and functions of I.C.A.O. outside air law's natural or agreed limits. It would, in fact, regulate all space-craft relationships, both internal and with the outside "world." It would obviously be the proper body for establishing an impartial and independent inspectorate for examining (as suggested by Mr. Aaronson) the contents of any State-owned space vehicles before they are launched into space. But the prior question of introducing the "flag state" concept into the new regime should be approached with the greatest caution. It is encouraging to note that the Law of the Sea Conference§ last spring definitely strengthened the "neutral" status of "ships employed on the official service of an intergovernmental organization flying the flag of the organization." That is just where the Law of Space should begin.

The new Agency would be concerned, of course, not only with these primary issues of U.N. sovereignty over outer space, but with many branches of the law of persons, e.g., with injuries and crimes, marriage and domestic affairs, business contracts and property rights, and much else.

Naturally, if crew and passengers are away for a very long time, they will probably pass through the whole gamut of personal relationships, and these must be taken care of by the new code. Drawing a will may not present many fresh legal problems, perhaps. But what if children are produced on a trip to or from the Moon? When the first earthly baby is born on a space-ship, under U.N. jurisdiction, would it not become, *legally*, the first world citizen?

†*See Chapter V, "Revolution on East River," by the present author (1956, Abelard-Schuman, Ltd., London and New York).*

‡*"International Law and High Altitude Flights : Balloons, Rockets and Man-Made Satellites." International and Comparative Law Quarterly, Vol. 6, p. 492 (1957).*

§*U.N. document A/CONF. 13/L. 53, page 4.*

Fig. 1 (left) Cruising glide at about 30 kt. The wings are held straight out, with slight anhedral. Note the tubular nostrils, which may be used as a pitot tube. Fig. 2 (right) Low-speed glide. The tail is spread and the feet are drooped, probably acting as split flaps. Slight outside aileron is being applied by downward twisting of the primary feathers of the port wing.

All-weather Amphibian

SOME THOUGHTS ON THE AERODYNAMIC CHARACTERISTICS OF THE FULMAR (NON-FAIREY TYPE)

By C. J. Pennycuick, B.A.

THE first prototype bird was a sort of lizard with feathers on its arms, legs and tail, which glided from tree to tree in order to elude its enemies. That was some 150 million years ago, and the birds have come a long way since then. Nowadays there are thousands of species of them, living everywhere from tropical forests to the Arctic pack-ice, and mostly specializing in subtle types of flight only remotely comparable with that of man-made aircraft. However, in the gliding flight of larger birds it is possible to analyse movements in terms familiar in connection with fixed-wing aeroplanes, and thereby gain an insight into the limitations of the latter somewhat crude devices.

Bird aerodynamics are concerned not merely with the effects of airflow on a body of known shape, but also with the way in which the creature alters its shape in order to make the most of the conditions of the moment.

The fulmar is a bird whose flight is especially pleasing to the eye, and it is also particularly convenient for the study of gliding flight. Fulmars are basically oceanic birds, spending most of their lives skimming over the surface of the sea, but in summer they congregate on sea cliffs to breed. A fulmar never flaps its wings unless it absolutely has to, and when it is not engaged in sitting on its egg or conversing with its mate, its favourite pastime is gliding up and down, round and round, in front of the cliff face. Furthermore, fulmars are very inquisitive, and the bird watcher has only to appear provocatively on the cliff top in order to attract a steady stream of subjects for study.

To explain how the fulmar flies it is first necessary to give a brief description of its anatomy. The bird has a span of about four feet, with the wings set amidships and mounted high. Each wing consists of two sections: the inner is supported on the upper arm and forearm, and when fully extended makes up about two-fifths of the distance from root to tip. The outer section comprises the wrist and hand (reduced to two fingers fused together), and the primary feathers which radiate outwards from it, so that the total length from wrist to wing-tip accounts for the other three-fifths of the wing. Within fairly wide limits the sweep back or forward of these two sections, and their dihedral or anhedral angles, can be altered independently.

The lifting surface of the wing is covered with overlapping feathers. The trailing and outer portions consist of a single row of stiff, flat feathers which overlap to form a single sheet; and, as the feathers can slide over one another when the wing is flexed, the wing area and the shape of the aerofoil section are under the control of the bird—as the wings are swept forward the area is increased, when they are swept back it is reduced.

Alterations of sweep are used in the control of pitching and airspeed: moving the lifting area forward or back relative to the centre of gravity produces nose-up or nose-down moments. This is easily seen when a steadily gliding bird hits a bump.

When a bird is gliding at its cruising speed (about 30 knots) in a gentle updraught, the wings are held straight out from the body, curved slightly downwards, so that there is a gently increasing anhedral towards the tips (Fig. 1). If it now hits a bump which pitches it nose-up, the most obvious movement is a sharp downward flap of the wings; but the action is accompanied by a sweeping back from the wrists and associated reduction in area, and it is this which actually corrects the bump. The reason for the downward flap is probably to keep the lateral stability constant—sweeping the wings back increases stability, so some extra anhedral is necessary to offset this effect. Conversely, if the bird hits a downwards bump, it momentarily sweeps its wings forwards, and at the same time raises them, putting on a little dihedral.

Sweep and dihedral are probably interlocked in the bird's nervous system, so that a change of one is automatically accompanied by a compensating change in the other. The connection can be seen in steady flight at different speeds: in a fast dive the fulmar hunches its wrists in and sweeps the primary feathers back till they are parallel with the body, reducing the span to a half or less of its maximum. The wings are curled down at the wrists, and the bird comes tearing down with a rushing sound that can be heard a long way off. When it is inspecting a nesting ledge it does exactly the opposite. It approaches the cliff in a shallow dive, then pulls up, spreading its wings forwards and upwards until, at its closest approach to the cliff before it turns and dives away, every feather is spread to the maximum extent, and the tail and webbed feet are spread as well (Figs. 3 and 4). [*Contd. overleaf*

Fig. 3 (left). Steep glide: the inner sections of the wings are shortened by flexing the elbow, the outer sections (wrist and hand) swept back. Extra anhedral is applied to reduce stability in opposition to the sweepback. The feet are swung forward as airbrakes.

Fig. 4 (right). Minimum speed: Wings spread fully and swept forward, with compensating dihedral. The tail is spread to act as a central flap, and the feet are drooped, probably acting as split flaps.

ALL-WEATHER AMPHIBIAN . . .

Fig. 5 (left). The stall: the starboard wing is fluttering, and its feathers are being lifted up at the trailing edge. The bird is turning away from a cliff and is about to dive away; it is making no attempt to counteract the stall by spreading its tail feathers.

Fig. 6 (right). A steep turn at very low speed. Coarse aileron is applied by twisting the whole length of the wing from the shoulder.

In these close approaches the speed often drops just a little bit too low. As the bird turns, the wings suddenly start to flutter (Fig. 5). The leading edge stays still, but the trailing edge oscillates up and down, and individual feathers are lifted up and curled forwards. This fluttering is often accompanied by a sharp, brick-like descent, and is probably a low-speed stall, although with plenty of dihedral it is a very innocuous one—and does not seem to worry the bird in the least. The same fluttering is sometimes seen in a steep turn, but I have never seen a fulmar flick.

The fulmar's ailerons are just like those of an aeroplane, only more so. For gentle aileron movements it deflects the primary feathers of the hand up or down (Fig. 2), whereas for really coarse movements at low speeds it rotates the whole wing bodily from the shoulder (Fig. 6). How it keeps the ball in the middle is not easy to see, but probably it shortens one wing a little and by suitable twisting keeps the drag moments of the two wings equal while they develop different amounts of lift.

This covers the basic control movements in pitch, roll and yaw, and it will be noticed that none of them involves the tail. The reason is that if you can twist and bend your wings enough there is no need for a tail. Applying sideways forces on the end of a long lever is, after all, a very crude way of controlling the behaviour of the wings. The fulmar has a tail, but moulting birds often lose it for a short time, and their performance at cruising speeds is not noticeably impaired. It is set horizontally quite close behind the centre of gravity, and is of only slight importance in correcting small bumps in cruising flight. It is sometimes twisted around the longitudinal axis and moved up and down, but these movements bear no constant relation to what the bird is doing at the time.

The real function of the tail is more analogous to an aeroplane's flaps. At low speeds the tail is spread out fanwise, increasing its area by a factor of about three, and forms a large central flap.

Anticipating Follands by several million years the birds also hit on the idea of using the undercarriage as an airbrake, and this is important in most water birds, which have large webbed feet especially suitable for the purpose. The fulmar probably goes one better, and uses them also as split flaps, drooping them at a shallow angle under the tail as it totters on the brink of the stall in a weak updraught.

Fig. 7. Wind hovering: the large dihedral angle makes the bird very stable in roll. The angle of descent (and thus the position of hovering) is controlled by the feet. The tail is furled and cocked up out of the airstream.

The feet really come into play in wind hovering, in which the bird remains poised in one position in a powerful upcurrent, formed by a strong wind blowing against the cliff (Fig. 7). Aerodynamically, this is comparable with a slow, very steep descent; in other words, the bird must make its drag large and its L/D ratio low. Since rapid rolling movements are not required it also makes itself very stable. The wings are hunched in, swept forward to the wrists and then back to the tips, and may be raised to as much as 40 deg dihedral. The angle of descent is controlled by the feet, which are swung down into the airflow with the webs spread and curved forwards. Fore-and-aft rotation from the ankle joint then allows precise control of drag, hence of the angle of descent, and so of the position in which the bird hovers.

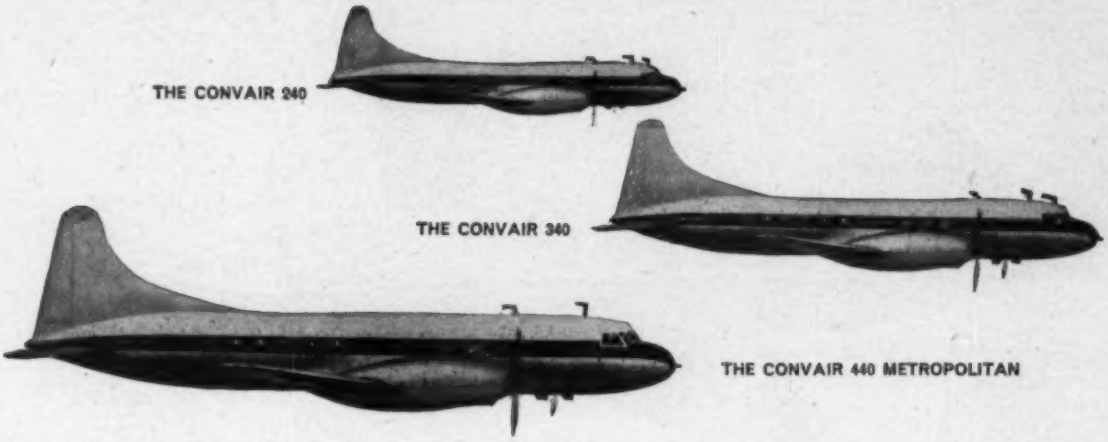
It is often stated that sea birds use the tail as an airbrake, but fulmars do not do this when wind-hovering. On the contrary, the tail is furled and raised so as to be in line with the airflow coming up from below. It is likely that in fully developed wind-hovering, which fulmars delight in demonstrating in a gale, the airspeed is above the maximum permissible for tail spreading.

At sea fulmars probably soar on the wind gradient, a trick which not even the gliding fraternity have managed to imitate, although its use by the albatrosses (which are larger relatives of the fulmar) has been understood for many years. This is a cyclic process—described, and analysed mathematically, by M. P. Idrac in 1924—involving repeated climb and descent between the surface and 50ft or so. Starting at the highest point, the bird sweeps back the outboard sections of its wings and goes into a fast glide downwind. As it descends, it runs into progressively more slowly moving air, which increases its airspeed until it arrives at the surface doing perhaps 60 kt. It now turns into wind, reduces speed, and zooms up. As it climbs it meets progressively faster moving air, which enables it to zoom back up to its original 50ft without losing airspeed. Describing a series of figures of eight in this way an albatross will keep pace with a ship over thousands of miles of ocean, and never flap its wings. The only limitation is that a moderate breeze is necessary.

It will no doubt have occurred to the reader that in order to perform with such virtuosity the fulmar must have continuous and precise information as to its airspeed. It is not definitely known how the fulmar obtains this, but a distinguishing feature of the group of birds to which the fulmar belongs is their peculiar tubular nostrils, from which they have been called the Tubinares, meaning tube-nosed. The nostrils in fact look extraordinarily like a pitot head. Although it turns its head to look around it the fulmar does, by and large, point its bill in the direction from which the relative airflow is coming; for example, in a steep descent it pulls its chin in and points its bill downwards. The use of a pitot tube for airspeed measurement is not the only method in use by flying animals: other systems are found in certain birds which are believed to measure the pressure on a sensitive patch of skin on the tip of the bill, while some flying insects measure the amount of bending of small sensory hairs on the head.

When a fulmar finds it absolutely impossible to utilize air movement in order to remain up it can, of course, provide the energy itself by flapping its wings; but that is another story, and a long one. Fulmars hate doing it, anyway, so I shall refrain from discussing the subject.

Although the young fulmar has to make its first solo from the cliff edge without ever reading *Pilots' Notes: Fulmar Mk 1*, one has to admit that on the whole it does remarkably well. It is perhaps conceivable that some brilliant designer could make an aeroplane whose wings were independently variable in area, sweepback, dihedral and camber, whose span was adjustable, and whose wings would, at the end of the day, fold neatly into the sides of the fuselage. He might even make it capable of swimming, refuelling itself, making love, and breeding other aeroplanes like itself. But think of training a pilot to fly it!



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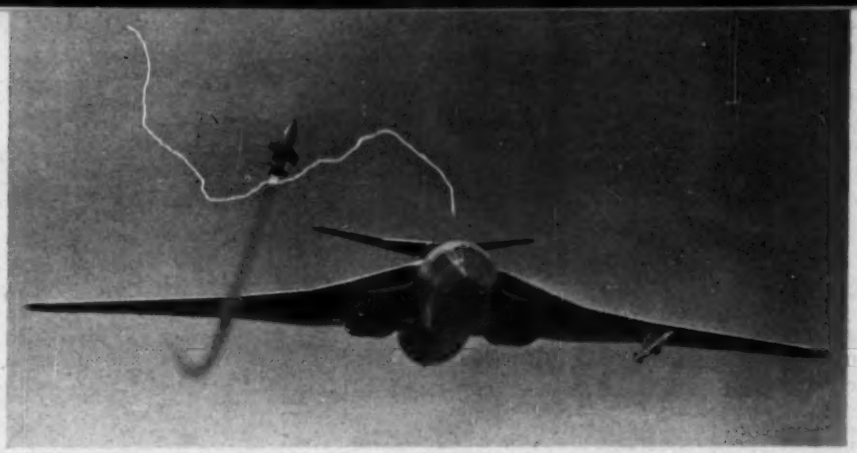


Handley Page Victor with air-to-air missiles: an artist's hypothesis.

SEEKING A SOLUTION TO THE PROBLEM OF OBTAINING LONG RANGE IN DEFENSIVE AIRCRAFT

By Don Adams

V-bombers as Intercepters?

THE recent disclosure in America that the forthcoming North American F-108 Mach 3 fighter would be armed with nuclear-headed "long-range" air-to-air missiles* suggests the interesting possibility that similar long-range defensive weapons could be used in conjunction with bomber-size subsonic "fighters." Perhaps even Britain's V-bomber force, or developments of Bristol Britannias, could be adapted to carry these missiles and fulfil the rôle of defensive fighters. Modification of these aircraft would lengthen their tenure of service and might well produce an effective defensive system at a fraction of the cost involved in developing new supersonic intercepters.

In the classical defence problem the rôle of the fighter aircraft is simply that of a weapons carrier. Current operational fighter squadrons employ short-range missiles with an effective killing range of between two and five miles. With this relatively limited range capability fighters must for all practical purposes follow World War 2 interception practices. Modern radar equipment allows all-weather attacks and permits a degree of flexibility in the selection of an interception course, but the current fighter must still get within close range of the enemy before firing a missile. Speed in current intercepters is therefore still essential, for, other things being equal, it is speed that ensures closing to an acceptable firing distance.

The development of the long-range defensive missile, however, minimizes the importance of the speed of the parent aircraft. If missiles could be constructed with a killing range of, arbitrarily, 50 miles, the missile-launching fighter need only close to something less than 50 miles. Speed may not be necessary to accomplish this function, particularly if the defending aircraft are judiciously dispersed in the path of the enemy intruders.

High-speed fighters will always have the ability to get somewhat closer to an attacker than their slow-speed counterparts, but the slight improvement in missile effectiveness at shorter ranges may not be significant. Some increase in booster impulse will be required if missiles are launched subsonically rather than supersonically. Offsetting this minor penalty, however, are the advantages of the subsonic aircraft.

There are many apparent reasons for favouring the large subsonic machine. Aircraft of the V-bomber or Britannia class have high endurances and can remain on station for long periods of time without having to be refuelled. The Canadian CL-44 Argus, a Britannia development, was specifically designed for long patrol missions and might be adapted to the fighter rôle. Few current fighters have the endurance necessary for continued patrol duty; and, indeed, this practice has nearly ceased. Large aircraft have a high payload capacity and could carry perhaps five to ten times as many missiles as conventional fighters. Fewer aircraft could be used to perform a given defence mission.

In subsonic aircraft, where some liberties can be taken in aerodynamic shape, very large search-radars could be carried without excessive performance losses. Supersonic machines, in contrast, must retain exceptionally clean lines. Picture the size of radar that could be installed in the nose of a Vulcan or Argus. Compare this with the small radar in the English Electric P.1B.

Pilots of the P.1Bs divide their attentions between watching a radar scope and flying the aircraft. Use of large aircraft in the fighter rôle would permit the assignment of radar specialists to full-time duty at the detection scopes. Enormous increases in the probability of detection would result, and enemy countermeasures could be more effectively met.

Many reasons thus exist for utilizing the subsonic fighter, provided that it can close in, or already be in a firing position, at an appropriate time. The problem of defending the United Kingdom resolves itself to one of protecting a relatively small island area with few primary targets. It would appear possible to defend this country with a number of large subsonic machines flying continuously on patrol. Distances between patrols could be adjusted so that adjacent units could supply reinforcements on short notice. "Point" defence of highly critical targets would still be provided by short-range ground-to-air missiles.

If the slow fighter has so many apparent advantages, it is logical to pose the question of why the U.S. and U.S.S.R. are not disposed to place high priority on its development. Defence of a large continental area with many widely scattered targets creates an entirely different situation. It is impossible, with any reasonable restriction on defence spending, to provide defence in depth along a frontier of 5,000 to 10,000 miles. Defensive units in the U.S. and U.S.S.R. are accordingly spread along the length of their frontiers, and have sufficient speed and mobility to counter threats anywhere along the defensive line. Speed in defensive aircraft is of prime importance if the area to be covered is large and the defensive forces limited. Speed is of lesser importance if the target area is small, as is the case in England. For these same reasons it would appear that a carrier task force could be successfully defended with "slow" aircraft.

Many people, of course, scoff at all thought of fighting a war in the archaic manner of 1939-1945. World War 3, it is contended, will be fought with huge hypersonic ballistic missiles. There are valid reasons for believing that future wars will be fought with these weapons, but there is a question of what is meant by "future." If the potential enemy possesses a massive force of intercontinental bombers, some defence must be provided against this immediate threat, concurrently with the making of preparations for a fighting war which might take place five to ten years from now.

If the subsonic fighter can indeed provide an adequate interim defence at a relatively low cost, then surely we owe it to ourselves to study the problem in detail. Simple operations research analyses should be able to answer the question of whether or not the comparatively slow fighter can do the job which may have to be done if the free world is to survive.

**The July 14, 1958, issue of "Newsweek" magazine made reference to a long-range U.S. Navy missile called Eagle, with a "50 to 100 mile" range.*

NEW ITALIAN LIGHT AIRCRAFT

THE Italian designer Stelio Frati—who was responsible for the Falco, Sparviero and Nibbio, among other types—has formed a company in Milan to build further new types of aircraft. During the coming year a number of 2/3-seat trainers with fixed nosewheel undercarriages are to be produced for the Italian flying clubs; and some aerobatic machines will also be completed.

The main effort is, however, to be concentrated on the F.400, a new two-seater touring machine powered by a single Turboméca Marboré. Preliminary information suggests that at least one of the two projected prototypes will be ready for the Paris Show next year and that the type will be easy to fly and will cruise for at least 620 miles at heights requiring neither pressurization nor oxygen. The price will be reasonable and full CAR.3 certification will be sought. Fuel consumption, it is forecast, will be about the same as that of a large American car or of the Ferrari or Mercedes sports cars. It is also reported from Milan that the new Frati aircraft will have special low-pressure balloon tyres intended to facilitate operations from unprepared ground.

Finding a Path

—THROUGH PEACE AND WAR: A.V-M. BENNETT'S AUTOBIOGRAPHY

DETERMINATION engenders intolerance; and both, if not virtues, are prerequisites in the character of a war leader. So it is that great men of arms are frequently found "difficult" in peacetime, their ideas and methods less acceptable in a softer society where the tedium of commerce and politics replace the whip-crack action of bombs and bullets.

A.V-M. D. C. T. Bennett, whose autobiography* has just been published, brought exceptional natural determination both to peacetime pioneering and to war. Rightly, many will say, he displayed marked intolerance of those who resisted his ideas and plans, particularly if they did so under the banner of officialism.

His book carries the subtitle "Wartime Memoirs"—a little misleadingly, for the main title *Pathfinder* (in one word) reflects the author's full and energetic life and not simply his wartime work with Path Finder Force. Actually, nearly half the chapters are devoted to Bennett's early days in the R.A.F., his introduction to flying-boats; his remarkable long-distance flight from Dundee to the Orange River, South Africa, in *Mercury*, the upper component of the Short-Mayo composite aircraft; his Foynes-Montreal flight in *Mercury*, and the inaugural East-West Atlantic service of August 1939 in the Empire boat *Cabot*.

Pathfinder is intensely interesting when it is dealing with personal experience, but it becomes weaker, and at times petty, when there are repeated derogatory remarks about bomber groups and their commanders, particularly 5 Group and A.V-M. (as he was then) Cochrane (who is consistently spelt without the final e). When dealing with matters outside his own bomber group the author often bases his remarks on misapprehensions and half-truths, and there appears at times to be a surprising degree of prejudice underlying them. His views on the controversial matter of whether to carry one or two pilots in a bomber in the later stages of the war were certainly not shared by all crews.

Bennett's own wartime experiences, his part in the organization of the first air deliveries of aircraft from America, his attack on the Tirpitz at Aasfjord and subsequent "walk" home, and such incidentals as his first test of FIDO are of absorbing interest. At this time he probably ranked as No. 1 airman of the world, having exceptionally broad experience for his years and top qualifications in all flying duties. He was truly a path-finder.

B.O.A.C. "Political Nonsense"

While the reader may enjoy most the chapters describing peacetime flying achievements, his thoughts will inevitably dwell on the descriptions of wartime developments and operations. There will be more sympathy for Bennett's stinging civil-aviation criticisms (such as that concerned with the formation of B.O.A.C.) than of the more personal ones while he served in Bomber Command. Of B.O.A.C. he writes:—

"During 1939 the British Overseas Airways Corporation Act came into force. This Act, in my view, was one of the most remarkable pieces of political nonsense that I have seen. . . . Beside Imperial Airways there had also grown up a small company in England, operated principally by people who were critics of Imperial Airways, mainly through personal animosity of one sort or another. As I understand their history they had not been financially successful and it seemed to me that they used almost entirely foreign aircraft—Dutch, German and American—without ever operating British aircraft on a regular basis. They managed to get a Conservative Government to nationalize the international civil aviation of Great Britain under one heading—B.O.A.C. Imperial Airways shareholders received somewhat less than the market value of their shares, whilst those of the small company with such a *distinguished record* were paid most generously for shares. What was more serious, however, was that the technical heads of the small company were given the key positions in the new corporation and complete control of the new airline. Moreover, the pioneers of the Empire air routes were given no recognition."

Before Path Finder Force was formed Bennett was consulted on more than one occasion, as much in his capacity as navigator as of pilot, and of these events he writes:—

". . . the British Government had at last given Bomber Command permission to retaliate, and to the horror of everybody concerned the retaliation was a ghastly failure. . . . The Directorate of Bombing Operations showed me raid reports which described excellent raids, and then showed me P.R.U. photos of the target . . . which showed not the slightest sign of damage of any sort.

"I looked at the assembled company and I simply asked a question. 'You are all experienced general duties officers; you have been flying a lifetime. Could you get into an aircraft on a pitch-black night, fly for three or four hours on a compass and an air-speed indicator, find a pinpoint in central Germany, avoid spoofs and dummies, not be put off by night fighters, flak and searchlights, and guarantee success?'

"I pointed out, however, that if a force of experienced navigators were to lead the crews, and if such navigators were to be given somewhat better equipment than that available in ordinary bomber aircraft, the chances of success were relatively high, and if they were then given fireworks of some description with which to attract the main force to the target it should be possible for them to act effectively as leaders. . . ."

Eventually the Path Finder proposal was adopted, and on July 5, 1942, A. Cdre. Bennett was appointed to command the force.

Recalling an historic occasion the author writes of a particular Oboe sky-marking raid on Essen:—

"This took place on January 9, 1943. The C-in-C. detailed a moderate little force of Lancasters to bomb on sky-markers, and all went well. There was complete solid cloud cover below, unlike the better conditions which had prevailed on the other sky-marking raids already carried out. Thus it was quite clear to those on the ground that the most valuable target in Germany, Krupps works at Essen, was being hit by a blind bombing method. Hitler immediately called a meeting and apparently he was most violent in his denial that such a thing was possible."

Many will agree with A.V-M. Bennett that

". . . the members of the public of Great Britain and the Commonwealth probably have no idea of the existence of Oboe, and have certainly never heard of Reeves, who invented it with the able assistance of Dr. F. E. Jones, and a small team of enthusiastic 'boffins.' MacMullen, Bufton, Slim Somerville and the rest of the boys in the Oboe squadrons got their D.S.O.s and their D.F.C.s by the sheer weight of their obvious bravery on operations. The inventor of the equipment, however, got precisely nothing."

No. 5 Group Criticized

Among many paragraphs critical of 5 Group, A.V-M. Cochrane, the author gives one late and grudging credit when he says: "Number 5 Group operated successfully on their own on this type of target [V.1 sites] and did good work." Elsewhere he writes:—

"In the rest of 1944 . . . 5 Group sometimes joined in with the rest of the command on proper P.F.F. marking but otherwise attacked on their own a large variety of small targets, most of them comparatively undefended. . . . In addition to these targets, 5 Group did go to a few German cities alone."

Then, again, in connection with a proposal from Cochrane to attack some lock-gates between Hanover and Berlin with 8,000 and 12,000 lb bombs, he writes almost as if the two had separate wars on hand: "I need not comment on the remarkable nerve of the A.O.C. of 5 Group in asking us to co-operate in view of the way he had treated us and weakened us both in strength and in name. . . ."

Of the Peenemunde raid A.V-M. Bennett says:—

"We were allowed to use a Master Bomber to assist in directing the attack, largely because 5 Group had started their intense line of independence and had been allowed to use a Master Bomber on an easy undefended target at Friedrichshafen in a little show which they did on their own. Our results on Peenemunde . . . were excellent. . . . The C-in-C. and the A.O.C. of No. 5 Group had much excitement and amusement by laying on some of the Main Force bombers from 5 Group to check the reliability and accuracy of the Path Finder Force for cross-checking their own results, and it was quite quaint that there should be such a 'to do' over what was a perfectly normal navigational procedure. In fact, at the time, it was the 'be-all and end-all' of the war so far as the A.O.C. of No. 5 Group was concerned. . . ."

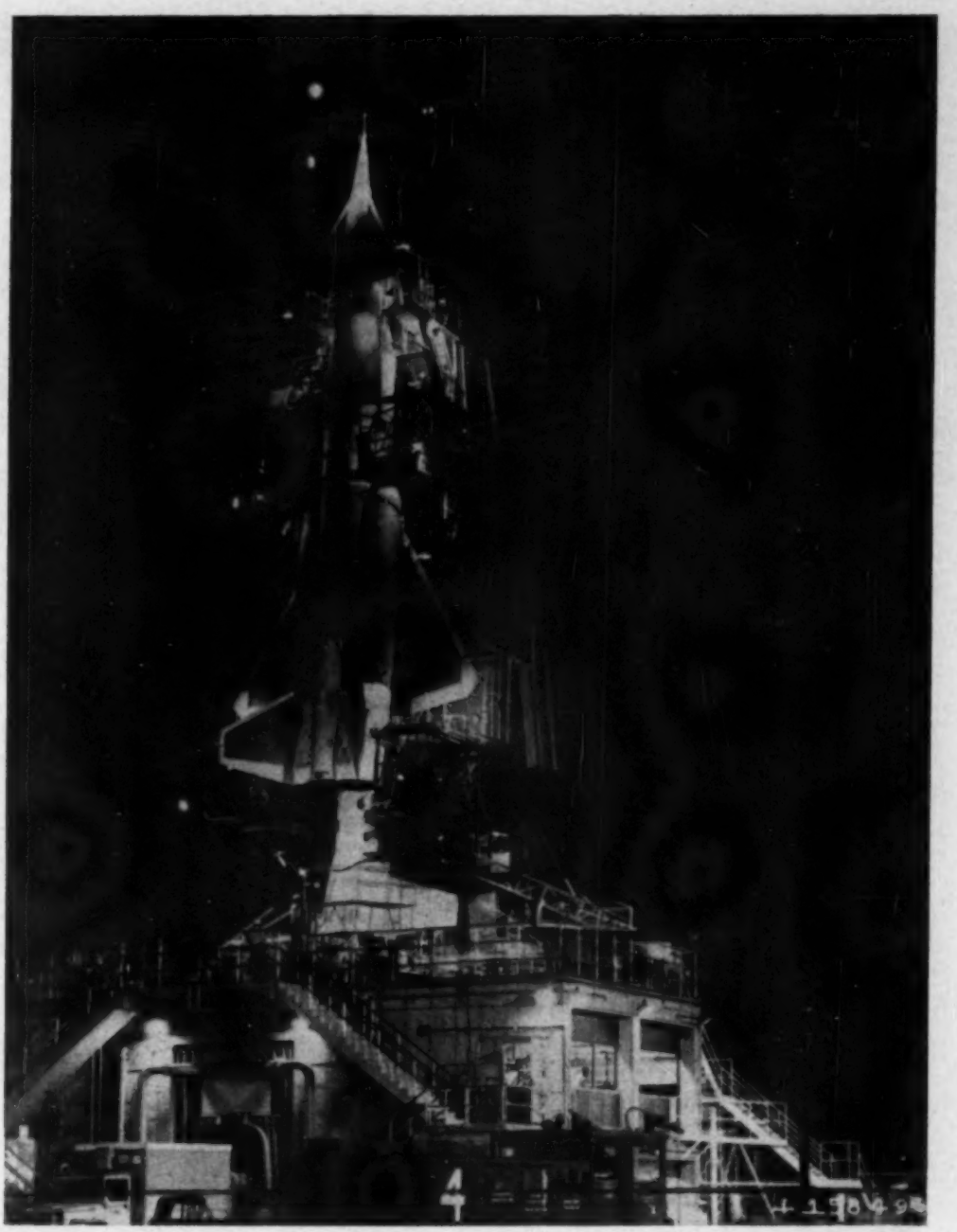
He then goes on to say:—

"It is perhaps wise from the point of view of students of air strength and its history to pay Ralph Cochran the compliment of expanding a little on his methods and on his results. I would emphasize that I have never fallen out with Ralph Cochran, and those who used to gossip during the war, saying that there was a feud between us, overlooked the fact that we were personal friends and I believe we still are."

Without doubt, P.F.F. marking and leadership turned near-failure in the early night bombing offensive into outstanding success. Without them and the associated aids of Oboe and H_2S, it is unlikely that the war would have been won. As the scale of the offensive increased with time, area targets such as industrial sections of cities, were joined by precision targets such as viaducts, tunnels, ships and oil refineries, beyond the range of Oboe precision marking. Neither sky nor H_2S ground marking could be used with certainty; clear weather and pinpoint aiming were then essential to success. It was on this sort of target, requiring a relatively small bombing force, that 5 Group were employed (while P.F.F. led the main force of other groups, as required). Low-level Mosquito searching and marking were feasible and effective for such work.

Soon after the war A.V-M. Bennett was elected Liberal M.P. for Middlesbrough West. Here the autobiography ends—which is disappointing for those of us who would like to read the personal views on British South American Airways (and its Yorks, Lancastrians and Tudors) of the man who was that organization's director and general manager from 1945 to 1948. M. A. S.

*"*Pathfinder*," by A.V-M. D. C. T. Bennett, C.B., C.B.E., D.S.O. Frederick Muller, Ltd., 110 Fleet Street, London, E.C.4. Illustrated. Price 18s.*



NAVAHO

IT might be thought that there is a place for an unmanned, winged, nuclear delivery system capable of flying at over Mach 3 at about 100,000ft for 5,500 nautical miles, and of evading enemy defences by means of sophisticated countermeasures and its ability to manœuvre. Several years ago the U.S. Air Force initiated the development of such a device, as Weapon System 104. To North American Aviation went enormous contracts for research and development which were shared among nearly all the company's divisions and immeasurably assisted their accelerated progress and acquisition of knowledge in the fields of rocket propulsion, inertial guidance and very high-speed flight. Finally, however, WS-104 began to appear uneconomic; the entire programme was thereupon cancelled, after it had absorbed $690m. The vehicular part of WS-104 is the SM-64A Navaho. Approximately the length of a B-47, Navaho was powered by two 48in Curtiss-Wright ramjets (the most powerful air-breathing engines ever made) and was launched vertically while riding pick-a-back upon a boost package containing either two or three rocket motors with an aggregate thrust of between 330,000 and 405,000 lb. These pictures show the awesome vehicle, which is much the fastest of its size to have flown in the western world. Points of interest include a canard foreplane, horn-balanced ailerons and a butterfly tail. From Navaho are descended the Hound Dog missile, the F-108 intercepter, the B-70 Valkyrie bomber and perhaps a Mach 3 transport.

Westland Westminster

A 16-TON TWIN-ENGINED TRANSPORT HELICOPTER

WHEN Westland remark that the great Eland-powered Westminster is "just an ordinary helicopter drawn on bigger pieces of paper," they hardly do justice to their own achievement in designing, building and flying the machine. But they are rightly proud of the fact that the first machine, which is entirely a private venture, is the best that could be produced with the resources available. It is indeed very close to the best that could be achieved even with unlimited backing; and it was done without affecting the development of the Wessex.

Rudely nicknamed "the flying cut-away drawing," the first prototype has, in fact, been constructed as a rig to test all those components which require live development. The girder-like frame is the simplest possible welded-steel tube structure and serves to locate the fully engineered cockpit, powerplant, transmission, rotor system and undercarriage. Neither engines nor the Westland-built portion of the transmission had ever been run before the initial ground trials were made in preparation for the first flight on June 15; and the Eland 229s are "one off" units specially made up and loaned by D. Napier and Son, Ltd. The fuel tanks are Whirlwind overload tanks with extended centre sections; the main wheels are those of a Bristol Freighter lightened by removal of half the brakes, and the final reduction stage, main and tail rotors, tail-rotor drive, pylon and tailwheel are Sikorsky S-56 units shipped direct from Connecticut. The steel-tube "fuselage" was made up by jig-welding the junctions and then assembling the frame between two rotating platforms. Wherever possible, existing parts have been used in order to simplify design and assembly. Even so, the first seven air hours, comprising ten flights (including a considerable number of demonstrations to "visiting firemen"), were largely trouble-free. Some 20 hr of tie-down testing prior to the first flight were completed in only 12 days.

Westlands have long considered the construction of a large helicopter for either military or airline use. In April 1951, in response to a specification issued by the Cribbett Committee, they proposed a 30-seater powered by a Double Mamba. In the following year a further proposal was submitted in response to a B.E.A. specification. This was to be a 50-seater powered either by four Rolls-Royce Darts or three Napier Elands, respectively driving through four or three bevel gears to the main-rotor shaft. It is noteworthy that this proposal included a waterproofed hull and sponsons to allow emergency landing on water—a feature which pre-dated the other water-landing schemes such as that of the Sikorsky S-62. The main undercarriage units were to have been retracted within float-like structures mounted at the tips of the sponsons.

It was in August 1954 that Westlands considered a re-engineered version of the Sikorsky S-56. Either Rolls-Royce Tynes or Napier Elands could have been fitted; and one scheme entailed simply the replacement of the S-56's piston engines with one of the turboprop types just mentioned. Following Sikorsky experience with the S-56 Westland determined to follow their original preference for placing the engines side-by-side above the main cabin.

By July 1955 the Yeovil firm had negotiated the licence to produce the S-56, and a design-study for a version of the Westminster, based on the S-56, was submitted to M.o.S. But no official support was forthcoming, so Westland made the courageous decision to go ahead with the design as a private venture; and, as their resources were not unlimited, they concentrated on simplifying the first machine. Partly for this reason and partly because there were no fixed requirements for a specific fuselage layout,

The steel-tube girder frame of the first Westminster locates the cockpit, engine, transmission and rotor systems of the first prototype. The second machine, also fitted for crane duties, will have a similar layout. The men seen working in the picture above give scale to the machine.

the steel-tube "space frame" was chosen as the best basis for testing and flying the whole propulsion and control system. In this way it became possible to offer a proven helicopter with an almost unlimited choice of fuselage configurations to suit any military or civil requirement which might later emerge. In addition, the stiffness and strength requirements of the definitive fuselage could be thoroughly established by full-scale tests with the girder frame and built into a fuselage from the start.

There are, nevertheless, certain applications for which the space-frame layout is particularly suited, e.g., for flying-crane work. Because the construction of the first airframe was determined mainly according to the needs of simplicity and cheapness its weight is rather high. Nor are the engines yet developing their ultimate power. Construction of a second and lighter girder airframe is now in hand and, with much more powerful Elands of NEl.6 rating (3,500 s.h.p. each) the Westminster will become a really useful crane. It is intended that the true crane version should, in fact, also have a freight-carrying fuselage. Specialist rôles for military Westminsters might include that of missile carrier, or of shore-based anti-submarine patrol aircraft over what, for a helicopter, would be considered long ranges.

The portions of the Westminster above and at either end of the space frame can be considered as the nucleus of the definitive machine. Of this the complete tail rotor and its monocoque pylon are original Sikorsky S-56 components, as are the tail rotor drive shaft and bearings, the main two-stage epicyclic reduction and the complete rotor head and blade system. These have been blended with two Napier Eland 229s mounted side-by-side with their single jet pipes deflected outwards. The usual Eland propeller reduction gears and drives have been replaced by simple trumpet intakes and bullet fairings; and a modified version of the usual reduction gear has been incorporated in the rear drive system as the primary reduction stage. The fixed shaft drive is led from the rear of each Eland into a hydraulic two-bowl clutch designed to allow 2 per cent slip between engine and primary reduction. Aft of this, within intermediate casings, lie the two roller-and-cam freewheels. Two bevel gears turn each drive through 90 deg and transmit it via a spur gear to the main vertical rotor drive. The tail rotor drive is taken from a bevel gear at this point. The complete Napier/Westland powerplant and transmission weigh the same as the original Sikorsky piston-engine installation, yet produce almost twice the horsepower.

In theory the Westminster powerplant is a constant-speed system in which variations in load caused by pitch changes in the rotors provide a power-demand to the engines. Change in load causes a change in r.p.m. which is immediately sensed by a governor on each engine. Fuel input is then adjusted to maintain constant speed. But it is obvious that, with two fixed-shaft engines driving into a single fixed rotor shaft any difference in power output between the two engines would cause divergent load-shedding. Freewheels in each transmission would in any case isolate the drive of the lagging engine. To allow for the characteristics of each individual engine and accommodate the slight speed variations on which the governors rely for their signals, a hydraulic clutch has been interposed in each transmission. A constant 2 per cent slip in these clutches provides the necessary flexibility in the transmission.

In fact, each governor has a variable datum, controlled from levers on the centre console in the cockpit, so that various speeds can be selected to suit different flight regimes such as take-off, climb, cruise and hover. A hydraulic torquemeter is included in each primary reduction gearbox to indicate the shaft horsepower actually being developed.

If each engine is producing 1,500 h.p. to provide a total of 3,000 h.p. at the rotor, any power reduction in one engine is immediately sensed and compensated for by an increase in fuel flow to the "good" engine; and as this is already running at high r.p.m. it can supply the additional power without any time-lag and, particularly, without any special action on the part of the pilot. This is a most important feature because in the event of engine failure at a critical moment there is no time-lag between loss of power from one engine and delivery of full power from the other.

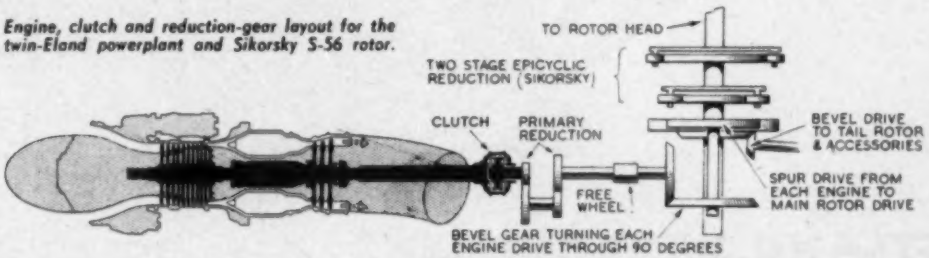
The second Westminster will have Elands of full NEl.6 rating, delivering 3,500 s.h.p. each; and some 3,500 h.p. is sufficient for flying at slow speeds near the hover. It can therefore be seen that complete loss of power from one Eland would leave the Westminster still immediately provided with considerable power.

There are three main powerplant controls in the Westminster cockpit—throttle, speed-selection lever and clutch control. The Elands are normally started and accelerated to the lowest governed speed of 10,500 r.p.m. by levers (located in the cockpit roof) which combine l-p. and h-p. cocks, and throttles. At this point, engine oil is circulating round the outer walls of the two clutches under pressure from engine-driven pumps, but the clutch vanes are dry and transmit negligible power. The next process is to activate the clutches; for this purpose one engine is accelerated with its speed selection lever (mounted on the centre console) to 11,800 r.p.m. The rotor brake is then released and the air in the clutches serves to speed the rotor up to about 20 per cent of clutch-engagement speed. The relevant clutch lever, also on the central console, is then moved progressively forward to feed engine oil, circulating under pressure, into the bowls of the clutch. A slight pause is allowed for the drive to take up and for the rotor to reach 140 r.p.m., after which the clutch control is moved fully forward to complete engagement. The rotor load then reduces the r.p.m. of the driving engine to 11,500. At this point the other clutch control may be immediately moved right forward to engage the second clutch, and the system is working. During normal operation, the datum of the governors is controlled from the two speed-selection levers to obtain r.p.m. suitable for ground idling, clutch engagement, stand-off flight, cruising and take-off and climb, the relevant positions being marked on the lever quadrants. There is no throttle control on the collective-pitch levers, as an increase in collective pitch—and therefore in rotor load—automatically causes an increase in engine power output.

The five-bladed main rotor and its controls are of Sikorsky design and, in the first machine, of Sikorsky manufacture. Conventional fixed and rotating stars form the swashplate system by which blade pitch is controlled through levers and push-rods.

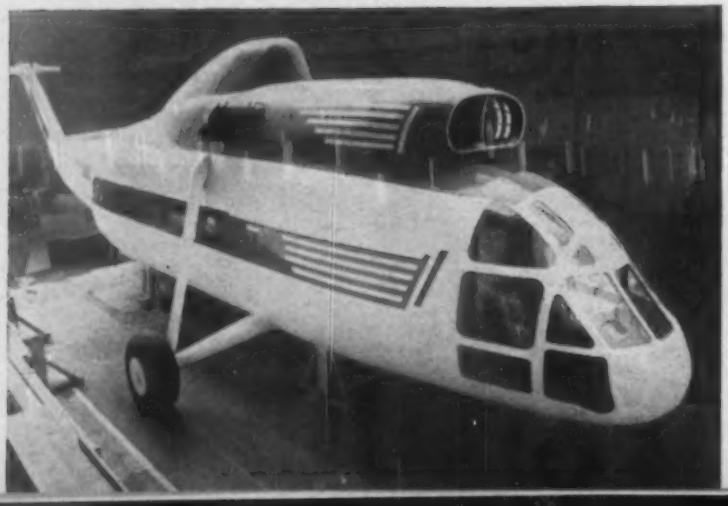
(*Continued on page 234, after cut-away drawing of the Westminster*)

Engine, clutch and reduction-gear layout for the twin-Eland powerplant and Sikorsky S-56 rotor.


TO ROTOR HEAD
TWO STAGE EPICYCLIC REDUCTION (SIKORSKY)
CLUTCH
PRIMARY REDUCTION
BEVEL DRIVE TO TAIL ROTOR & ACCESSORIES
SPUR DRIVE FROM EACH ENGINE TO MAIN ROTOR DRIVE
FREE WHEEL
BEVEL GEAR TURNING EACH ENGINE DRIVE THROUGH 90 DEGREES

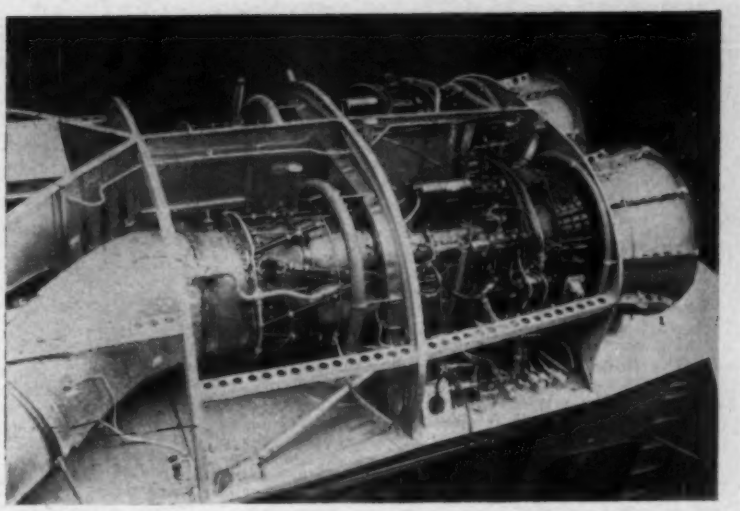
1 Tail rotor gearbox
2 Tail rotor coning-ring actuator
3 Tail rotor coning-ring
4 All-metal tail rotor blades
5 Tail rotor tandem hydraulic servo jack
6 Hinged access-fairing
7 Monocoque tail pylon
8 Intermediate gearbox
9 Tail rotor controls—cable, quadrant and push-rod
10 Tailwheel centring springs
11 Liquid Spring levered suspension
12 Tailwheel locking plunger
13 Flexibly mounted tail-shaft bearings
14 Tail rotor drive shaft
15 Primary and secondary hydraulic reservoirs and pressure controls
16 Transmission oil coolers
17 Rotor disc brake
18 Belt-driven oil-cooler fans
19 Main rotor pylon supports
20 Flying-control linkage
21 Main rotor tandem servo-jacks (3)
22 Hydraulic drag-dampers
23 Main rotor gearbox
24 Fuel drain tap
25 Main rotor gearbox oil tank
26 Oil tank access
27 Clutch (one for each engine)
28 Engine and clutch oil tank
29 Transmission shaft
30 Jet-pipe
31 Jet-pipe mounting
32 Firewall
33 Ventilating air to engine bay
34 Combustion chambers (six)
35 Engine breather-pipes
36 Outboard engine mounting
37 All-metal rotor blades
38 Engine lifting lugs
39 Starter motor
40 Speed control unit
41 Compressor bleed filter
42 Fuel recuperator
43 Fuel flow meter
44 Fuel filter
45 Engine oil filter
46 Front engine mounting
47 Access to flying controls
48 Engine cleaning-fluid pipe
49 Engine control tubes (4)
50 Roof console (engine starter panel)
51 Rotor brake lever
52 Flat window for screen wiper (each side)
53 Instrument-panel servicing door
54 Rudder pedals and toe brakes
55 Collective-pitch lever
56 Cyclic-pitch control column
57 Pilot's seat
58 Seat adjustment
59 Intercom ground connection
60 Crash switches
61 Emergency exit windows (each side)
62 Pneumatic brake reservoir pressure indicator
63 Flying-control tubes (4)
64 Flight test observer's bay
65 Flight observer's seat (on rails)
66 Crew entry platform (port side)
67 Engine fire-extinguisher bottle (each side)
68 Emergency fuel-transfer panel
69 Flying control mixing unit
70 Electric fuel-transfer pump (each tank)
71 Fuel tanks (250 Imp. gal each)
72 Air/oil undercarriage strut
73 Single tie-down or load-carrying point
74 Four struts connecting strongpoint to rotor head
75 External starter connections
76 External hydraulic-test connections
77 Jacking and ballast point for test purposes
78 Test observer's station (unoccupied)
79 Electrics and radio box (port side)

WESTLAND WESTMINSTER . . .



The mock-up of a 40-46 seat passenger version of the Westminster. Forward and after entrance doors are on the port side. Our feature drawing shows the girder frame of the first prototype, upon which a missile carrier or troop transport might be based.

The Eland 229 installation, uncowled and seen from starboard, showing transverse and longitudinal firewalls and distribution of accessories.



WESTLAND WESTMINSTER

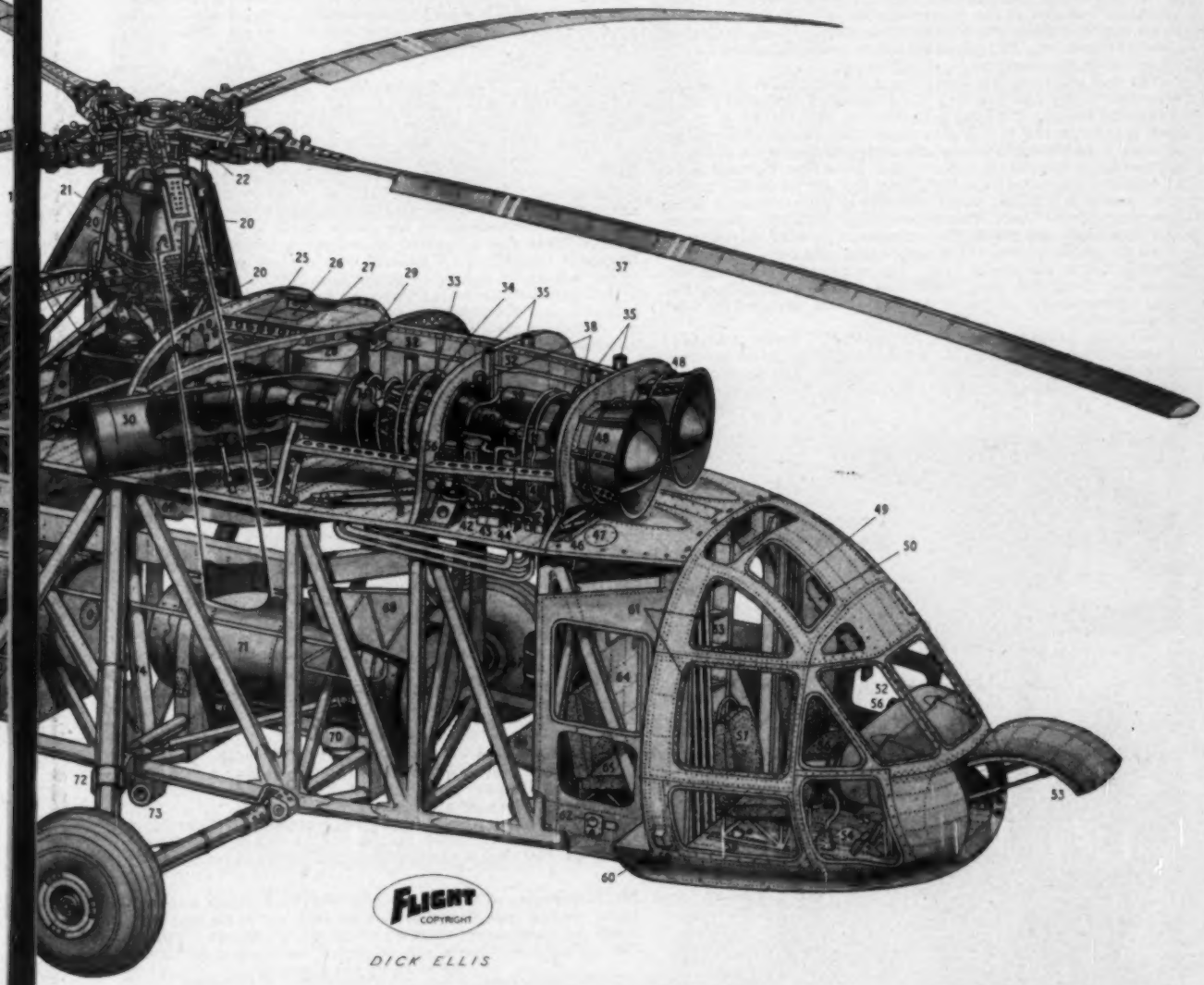
Two Napier Elands giving 3,300 s.h.p. each

(Figures for the crane version in parenthesis)

Overall length, 86ft 9in; overall height, 18ft 4in; main rotor diameter, 72ft; tail rotor diameter, 15ft.

Equipped weight, 21,245 lb (21,500 lb); disposable load, 11,755 lb (14,500 lb); normal gross weight, 33,000 lb (36,000 lb).

Sea-level cruising speed, 150 m.p.h. (115 m.p.h.); range, 390 miles with 4,000 lb payload (180 miles with 9,925 lb); vertical climb at 33,000 lb at max. continuous power, 1,200ft/min (1,200ft/min); climb at 85 m.p.h. at 33,000 lb with one engine at take-off power, 700ft/min (700ft/min); two-engined hovering ceiling, 8,500ft.



DICK ELLIS

WESTLAND WESTMINSTER . . .

Each blade has a flapping hinge, and drag freedom is restrained by a hydraulic damper. A positive stop, removed by centrifugal force while the rotor is turning, can engage a flange on each blade root to prevent flapping when the rotor is still. Following Sikorsky tradition, the design is conventional and straightforward.

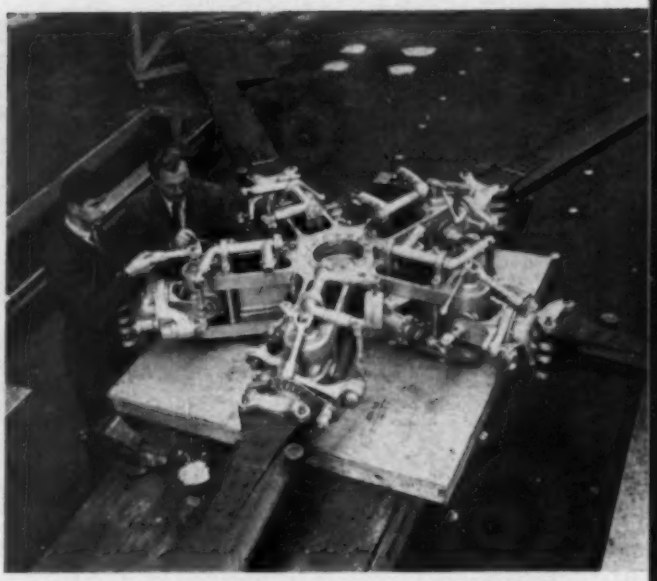
A duplicated full-power hydraulic system, also designed and made by Sikorsky, controls both main- and tail-rotor pitch changing. It is based on tandem jacks operating a single piston rod with two piston heads. Separate shuttle valves are operated by the pilot's input and centred by a feed-back linkage. No manual reversion is provided; but neither is there any record of complete powered-control failure in the Sikorsky system. In the case of the S-56 and the Westminster the operating pressure is 3,000 lb/sq in. Reservoirs and pressure controllers are concentrated in a unit mounted atop the space frame, beside the tail rotor shaft. Pressure is maintained by one pump in the accessory drive on the back of the main gearbox and by another pump on the port engine.

The transmission has its own lubricating system, the oil for which is cooled by flowing in parallel through fan-cooled oil coolers driven by belts from the tail rotor shaft. These coolers are, in fact, original S-56 units. The engine lubricating oil, which is also used to operate the clutches, is passed through oil coolers with Plannair fans, identical with those of the Rotodyne Elands.

The main undercarriage consists of main and tail units, the latter being an original S-56 assembly. As mentioned earlier, the mainwheels are those of a Bristol Freighter lightened by the removal of half the brake. The braking system is pneumatic, power being derived from stored air. In fact, these wheels are heavier than necessary for the Westminster, but the lighter wheels to be fitted to later machines will be of about the same size. It was originally intended to use raked radius-arms and shock-absorber struts similar to those of the Wessex, but computer studies showed a risk of resonance. The present A-frame, combined with a Dowty air/oil strut, has therefore been substituted.

The fuel system of the Westminster at present consists of two extended Whirlwind overload tanks mounted within the space frame and holding 250 Imp. gal each. An SPE booster pump in each tank raises fuel to a single collector tank beneath the engines whence a further pair of booster pumps feeds into a common pipe which is branched to either engine. Flow from the main tanks is balanced by two Flight Refuelling float-valves in the header tank; and a half-gallon recuperator allows for momentary negative g conditions. Tank contents are gauged by Smiths float units and flowmeters are fitted. For emergency transfer, compressor-bleed air can be led into either tank through the normal vent pipe to raise fuel to the header tank. The engine-driven pumps will draw fuel from this level. This fuel system is simplified, but fully representative of the two-section system intended for later Westminsters.

Electrical power is provided by two 6kW Rotax generators driven from the accessory pad on the rear of the main gearbox. Two inverters supply A.C. current for radio and instruments. Thorn pillar lighting and Plastek edge-lighting are applied respectively to dials and switch panels in the cockpit. No fewer than six external intercom sockets have been provided and have proved most useful for external observation during initial ground running.



The Westminster rotor head is identical with that of the Sikorsky S-56. Five all-metal blades are mounted with flapping hinges and hydraulic drag-dampers, pitch-changes being effected through a fixed and rotating star swashplate system.

Full dual control is provided in the first machine and the pilots are accommodated in sliding Rumbold seats. The pendant rudder pedals are mounted on pillars which can be tilted fore and aft to accommodate varying leg-lengths. Full blind-flying instrumentation is fitted; and the comprehensive group of engine instruments is accommodated on the central panel and console. The head of this section is reserved, in production aircraft, for a Decca Navigator Flight Log. Westlands have applied the new cockpit colour scheme of pale grey panels and black instrument dials.

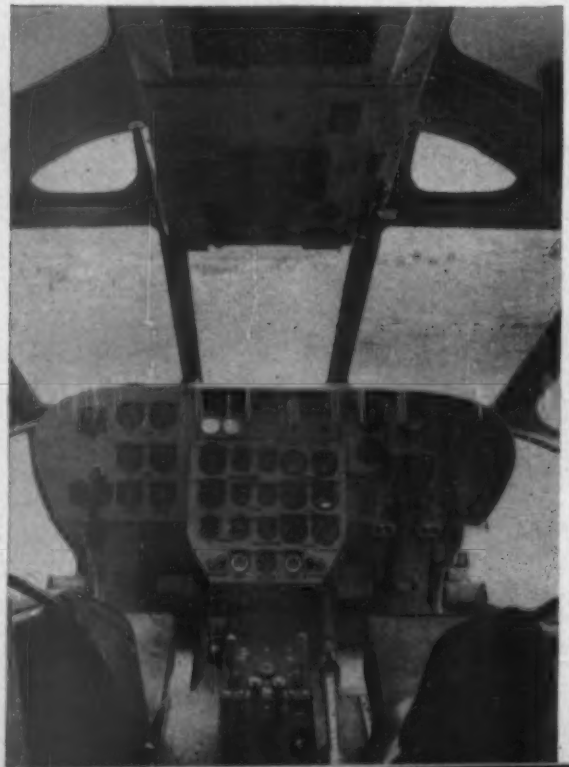
On the first machine, numerous external connections for hydraulic and electrical supplies required during ground testing are concentrated on two panels just aft of the starboard main undercarriage. Radio and electrical gear are concentrated in a large case in the port flank of the fuselage; and an auto-observer panel with two cameras and flood-lighting is mounted within the space frame, aft of the fuel tanks. All these units can be reached with the utmost ease.

The two Elands are mounted from trunnions supported by triangulated tubular structures based on the main floor on top of the frame, the engine bays being isolated and divided by transverse and longitudinal fire bulkheads and covered by single-curvature metal panels. Graviner Firewire and extinguisher spray rings, supplied by one bottle for each engine, give fire protection. Engine and transmission oil are held in two tanks, holding respectively 25 and 10 gal, located between the primary gearboxes.

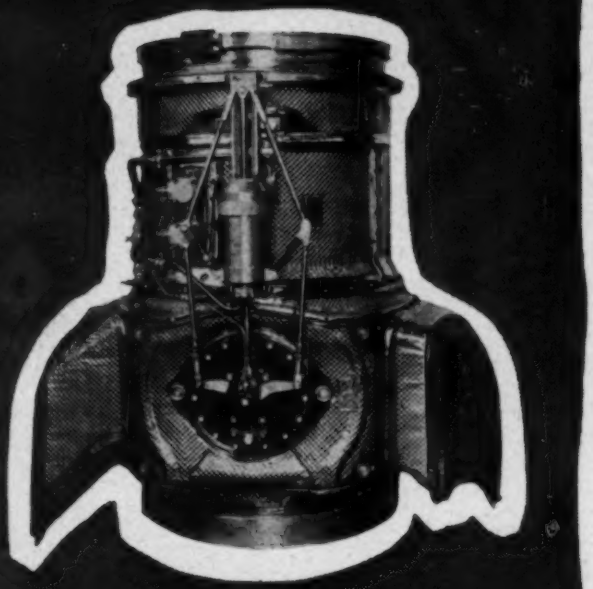
The original couplings for the high-speed shaft between the clutches and the Elands provided for engine and gearbox expansion but allowed very little universal play. The rotor mounting was therefore made very rigid. Subsequently, Westlands developed and patented a more flexible coupling which will allow a good deal of weight to be saved in the rotor mounting system of later machines.

As a transport the Westminster offers a cruising speed of 150 m.p.h. and a range of 100 miles with reserves at full load. The 40-seat cabin is arranged in rows of five seats abreast with a gangway 18in wide. Front and rear entrances, with built-in steps, lead into vestibules with shelves for carry-on luggage. A toilet is located between the flight deck and the main cabin. A feature of the seating layout is that it allows full freedom of passenger distribution without regard to c.g. limitations.

Over the shorter ranges the seat/mile cost of the Westminster will be competitive, though still somewhat higher than that of, say, a Viscount; but it will nevertheless be about one-sixth of the



The Westminster cockpit is pale grey with black panels and dials. Engine starting controls and rotor brake lever are in the roof, while clutch and speed-control levers are on the rear of the central console. The collective-pitch lever can be locked for cruising flight, and carries no throttle twist-grip.



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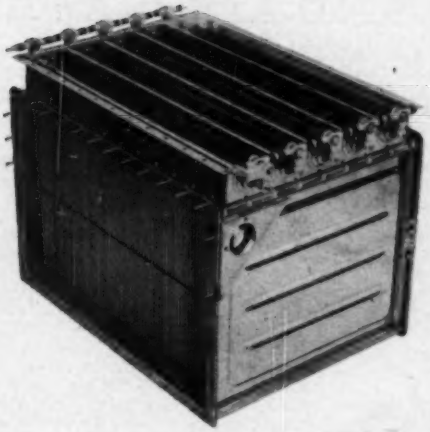
High pressure fuel-cooled oil coolers for high performance gas turbine engines. This unit is used in the Armstrong Siddeley Sapphire S.A.7.



Heat exchangers for many purposes in both aluminium alloy and stainless steel. This particular example is for the Vickers Vanguard's anti-icing system. Similar units are being supplied for the Fokker Friendship, the Bristol Britannia, the Armstrong Whitworth Freightliner, Vickers Viscount, and the Handley Page Herald.

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During its arduous proving flights the "Wessex" helicopter's gas turbine engine is running exclusively on AeroShell Turbine Fuel to get the finest performance out of this new aircraft.

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SHELL

WESTLAND WESTMINSTER . . .

cost being returned by helicopters at present in airline service. Westland point out, however, that relatively high seat-mile costs can be tolerated over the very short ranges, where a profitable fare would not be unreasonably high. For example, a seat-mile cost of 8d would, over a 20-mile stage, add up to 13s 4d, which would be competitive with surface travel on a route crossing London or the Channel. The price of fuel (or fuel tax) can also greatly affect helicopter costs. It is worthy of remark that Westland, some years ago, briefly considered fitting two Napier Nomads to a Westminster-sized helicopter. Payload would have been reduced by half, but the greatly reduced fuel consumption would have fully counterbalanced this effect.

The Westland team responsible for the Westminster is headed by Mr. D. L. Hollis Williams, technical director. Chief engineer is Mr. O. O. Fitzwilliams and chief designer Mr. Q. E. P. Shunker. Responsible for the mechanical design was Mr. G. Smith-Pert; and the assistant chief designer, Mr. J. Speechley, is in charge of the project. The chief test pilot, W. H. ("Slim") Sear, and his co-pilot, S/L. Leo de Vigne, have been at the controls during all flights to date. An intensive flight-test programme is continuing and the Westminster is being prepared to appear at Farnborough next month. C. M. L.

This view of the Westminster clearly shows the radio and electrics case in the port flank. The registration numbers are painted on plates providing a backing for the static pressure-sensing ports.

VARIATIONS IN THE IRISH AIR

A FINE, soft Irish day—a little gentle rain, a few showers and some brief moments of watery sunshine—greeted the opening of the Leinster Aero Club's fourth annual air display at Weston aerodrome over August bank holiday week-end. The club had hoped for better weather ("worst for 150 years" *Flight* was told at Collinstown Airport, Dublin; but then it was ever thus) for they had already postponed their show from June 28 and 29, when a waterlogged field and the prospect of further rain made a flying programme impossible.

So perhaps the visitors by air were fewer than the club would have liked; but with an open-heartedness typical of flying people in Eire, those who did come were warmly welcomed, and promptly written into the programme in whatever capacity they best could fill. Thus, early in the afternoon of Sunday, August 3, your reporter found himself looking up through the windscreen of *Flight's* Gemini at the wheels of Dennis Green's Bonanza a hundred and fifty yards ahead; beyond the Bonanza was the Marquess of Kildaire's Piper TriPacer; and beyond that a Tiger Moth, a Piper Cruiser and a Chipmunk. Behind trailed another Chipmunk, two B. A. Swallows, a Pobjoy-powered Klemm, another Tiger Moth and an Auster flown by Captain Kennedy, president of the club, bringing up the rear. This was the club circus, and every aircraft at Weston this bank holiday week-end —club, private owner and visitors alike—took part in a tail-chase around and across the quite small field. This is a friendly idea which other clubs might emulate.

Heaviest metal on the programme was a Viscount of Aer Lingus, which appeared immediately after the Marquess of Kildaire had opened the show. Exercising nice judgment, the Viscount pilot swept past a D.H. 84 Dragon just as the latter passed in front of the public enclosures: a popular demonstration of the equipment growth of the national airline.

Then for a few brief minutes the Aer Lingus captain showed off the Viscount in a way that airline pilots rarely have the opportunity to do; turns against two feathered engines; a dummy approach with one engine stopped and a very slow run past the crowd. Then came a heart-stopping trapeze act by M. René Vincent, suspended upside down (and often by one foot) beneath the club's Auster before making a parachute jump under a quilted canopy from the trapeze; a demonstration of crop-spraying by Peter West in one of Crop Culture (Aerial)'s Tiger Moths; and a demonstration of parachute supply dropping from the Dragon, which is in regular use in Ireland training members of the Irish parachute club.

Next Bob Magill and George Donohoe did their best under the low cloud-base with aerobatic performances in two Chipmunks; as the commentator said, they were "not very high up at all, almost in the cloud," but both managed a lively succession of loops, rolls and an aileron turn.

"Now," we were candidly told over the loudspeakers, "the programme is running thirty minutes late. I say three-oh, not one-three minutes late."

Next "modern private and executive aircraft"—the Bonanza, *Flight's* Gemini and the Piper TriPacer—each gave an impromptu few minutes' display while Weston airfield (complete with a dummy but terrifyingly loud gun) prepared for its defence. A red and white Proctor came low over the boundary and did its best to bomb "the fort" in the middle of the field; it was chased away by gunfire and by two Chipmunks. A marauding Dragon got very much the same treatment, except that the gunners—quite oblivious to their danger—found it necesary to poke down the business end of the weapon in the middle of the attack.

Then a display by a sailplane of the Dublin gliding club and a parachute jump by the C.F.I. of the Irish Parachute Club brought the display to an end. At least, it should have done so, but when Mrs. Pennyweather's schoolgirls should have been assembling at gate "B" a horse ran on to the airfield, the schoolgirls broke loose, the marshalls had all left their posts and the commentator's appeals for order were completely ignored. The girls—hotly pursued by a steward's 1913 (sleeve-valve) B.S.A.—jumped into some Tiger Moths, the wing of one of which promptly crumpled. St. Trinian's were on the rampage! When the aircraft took off, your reporter took cover, while the commentator, exhausted to a whimper of words, collapsed in his box. But St. Trinian's suspiciously competent schoolgirls landed safely, if hectically, and all were prepared for a second performance in the bright sunshine of Bank Holiday Monday the following day.

A. T. P.

NEW PROXIMITY-WARNING INDICATOR

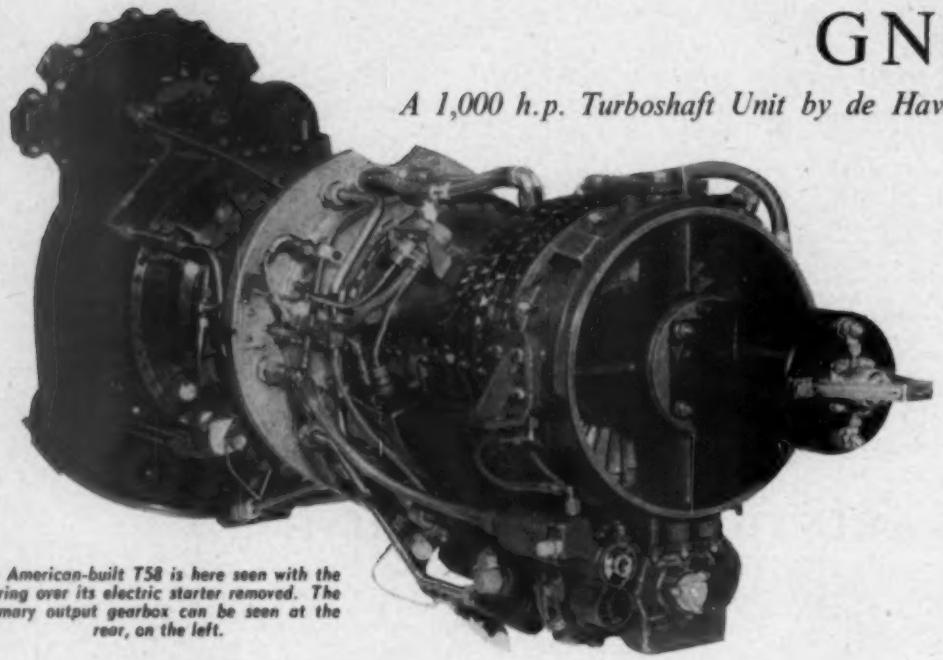
A NEW aircraft proximity-warning indicator is being developed by the Decker Corporation of Bala Cynwyd, Pennsylvania. While other companies are working on both radio and infra-red methods, Decker claim progress with a technique described as "modulated light," whereby light is transmitted through a thick glass plate set in ultrasonic plastic vibration. The vibration alters the optical properties of the glass and varies the polarization of the transmitted light.

Indicator panel of the Decker system, showing an intruder at 11 o'clock high.

Several types of modulation can be produced by using an accessory polarizer and quarter-wave plates; and if infra-red or ultra-violet wavelengths are used, the transmissions are invisible and cannot be jammed. Reception is by means of tuned-in sweep mirrors, photoelectric cells and demodulating equipment. Decker also claim that modulated light could be used for discreet, line-of-sight communications.

GNOME

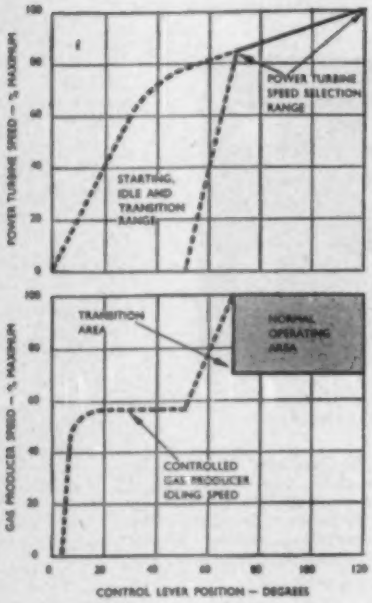
A 1,000 h.p. Turboshaft Unit by de Havilland Engines



An American-built T58 is here seen with the fairing over its electric starter removed. The primary output gearbox can be seen at the rear, on the left.

SINCE February the de Havilland Engine Company have been preparing an anglicized version of the American General Electric T58 turboshaft engine in order to provide a light and efficient thousand-horsepower gas turbine for the British market. Their licence with General Electric was concluded simply in order to buy the extensive experience of the American company, and de Havilland reckon it should give them a lead of some two years over their competitors.

An appraisal of the T58, and an outline of its development, was published in our issue of January 17, 1958. It is now possible to describe the engine in rather more detail and to give a brief resume of de Havilland's plans for marketing it. At the outset it is pertinent to comment that, although the design of the engine might be expected to be excessively complicated and to require heavy tooling investment and difficult manufacturing methods, the reverse has proved to be the case. General Electric have kept the unit essentially simple, and D.H. Engines are confident of their ability to manufacture it in quantity at a competitive price.


POWER TURBINE SPEED — % MAXIMUM
POWER TURBINE SPEED SELECTION RANGE
STARTING, IDLE AND TRANSITION RANGE
GAS PRODUCER SPEED — % MAXIMUM
TRANSITION AREA
NORMAL OPERATING AREA
CONTROLLED GAS PRODUCER IDLING SPEED
CONTROL LEVER POSITION — DEGREES

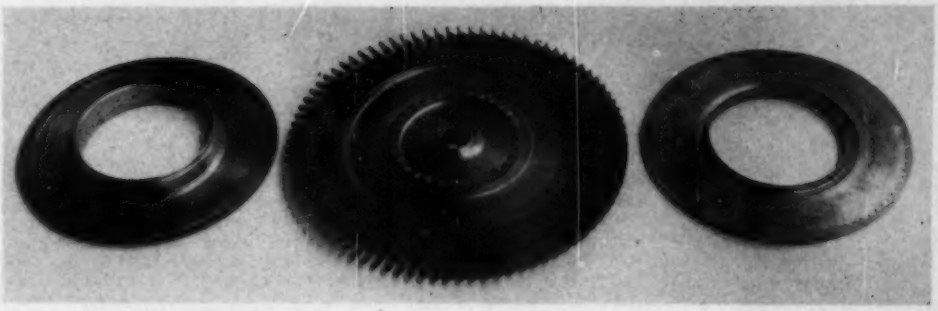
The curves on the left outline the basic control of the Gnome. The pilot's power lever controls gas-generator speed directly up to idling; thereafter gas-generator r.p.m. is held automatically to produce the h.p. required by the helicopter rotor.

Below is a cross-section of a compressor casing, indicating the geometry of the fixed and variable-incidence blades and their attachment. Steel is used throughout.

The basic gas generator, which can be used as the basis for a turboshaft helicopter engine, a turboprop or a turbojet, comprises a 10-stage compressor with four rows of variable stators and a two-stage turbine, the whole being supported in three bearings. The mechanically independent power turbine has a single stage and is carried overhung at the front of the two-bearing rear shaft.

At the front is an intake frame cast in aluminium alloy. Three of the four struts are de-iced by hot air and the "six o'clock" strut surrounds the drive to the engine accessories. In the centre of the frame is the housing for the front compressor bearing and an electric starter can be bolted to the front of the unit (an alternative means of starting is obtained by direct impingement of an air jet). General Electric conducted extensive research before deciding to employ an all-axial compressor, and the final unit has ten stages with variable inlet guide vanes and variable-incidence blading in the first three stator rows. The I.G.V.s and first stators are shrouded, and all four rows are operated together by external rings which are moved by a jack energized by engine fuel. Accompanying curves show the manner in which their incidence is varied; between the starting position and 85 per cent r.p.m. the blades move through an angular distance of 30 deg, and they then remain in the fully open position throughout the normal operating regime. General Electric report an overall (total pressure) efficiency of 84 per cent for this compressor, which is remarkable in view of its diminutive size.

In some respects the mechanical design of the compressor is unique. The last seven rotor stages are built up on a single stainless-steel forging, which is machined to provide a rigid, lightweight spool carrying inserted blades. The second-stage disc is integral with the forward extension shaft, the first stage being overhung from the second. The first disc carries a labyrinth forming the outer seal of the balance-piston cavity. Blades in the first two stages are sealed into diagonal slots in their discs and retained through conventional two-tang dovetail roots. The remaining blading is provided with transverse dovetails which are inserted into circumferential grooves machined in the spool, each



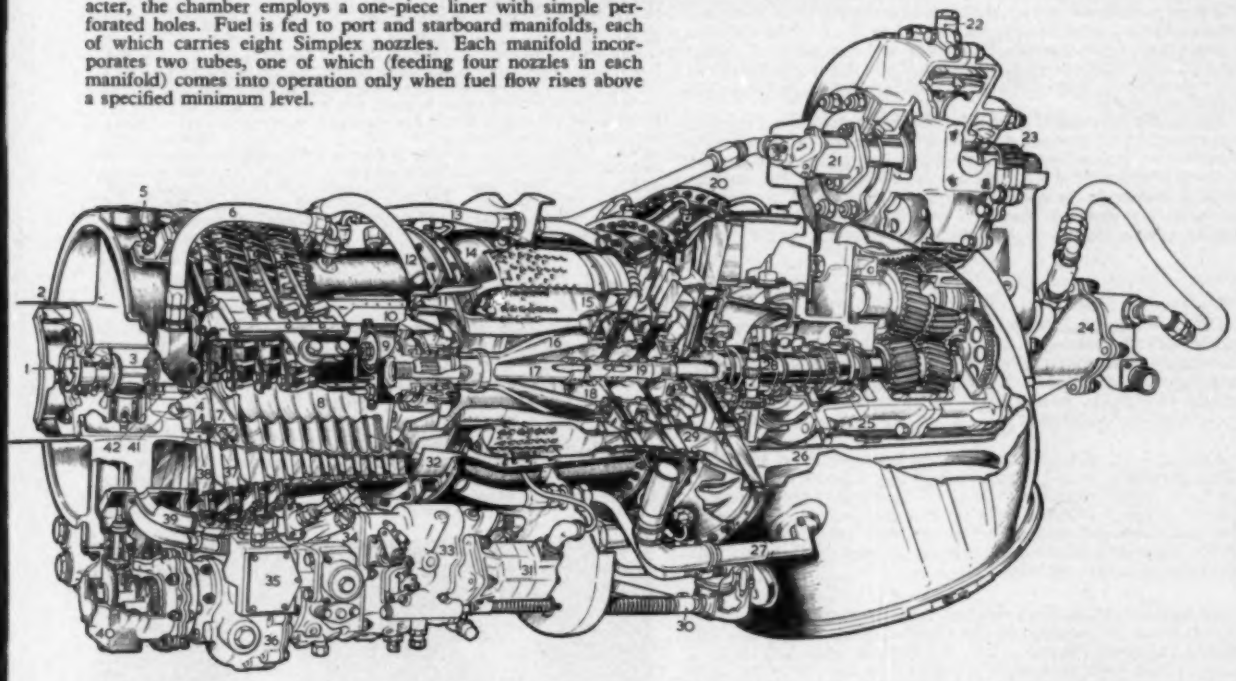
The first-stage gas-generator turbine comprises a conventional rotor disc, with inserted blades, and a pair of thin cooling plates which economize in cooling-air demands.

complete row being pushed round one blade at a time and the final blade being secured by a grub screw. Provided that the distribution of weight around each stage (owing to blade variations) is maintained in the condition for proper balance, G.E. have found it practicable to remove and replace as many as three complete stages of blades in the field with the engine installed. The final stages of rotor blading are some of the smallest in the world, and G.E. have evolved low-cost methods of production which will be generally followed by de Havilland.

An accompanying photograph shows a cross-section of the compressor stators, the casing for which is split into upper and lower halves. The first and second stages are supported at their shrouded inner ends, whereas the third and fourth rows are cantilevered from their variable-incidence bearings in the casing. The remaining rows are secured by stabbing and brazing into circumferential rings each holding two stages of blading. The fixed blading is fabricated from mill-rolled stock, steel being employed throughout.

After a great deal of development, a relatively simple design of combustion chamber has been evolved. Of truly annular character, the chamber employs a one-piece liner with simple perforated holes. Fuel is fed to port and starboard manifolds, each of which carries eight Simplex nozzles. Each manifold incorporates two tubes, one of which (feeding four nozzles in each manifold) comes into operation only when fuel flow rises above a specified minimum level.

As the cutaway drawing illustrates, the gas-generator turbine comprises two discs separated by a Curvic coupling and pinched together by a central tie-bolt. Drive to the compressor is effected through a conical tubular shaft which tapers towards the forward end (the converse of the Gyron) in order to pass through the centre bearing. The rotor blades have extended roots and are retained by dovetails. As a photograph shows, thin, machined cooling plates are mounted on both sides of each disc in order to constrain cooling air to follow the most effective path. A novel design feature is the use of a honeycomb seal, made from 521 material, in the centre of the second-stage nozzle assembly (see photograph on p. 238). All three nozzle assemblies are fabricated to exceptionally close tolerances and contribute to consistently high engine performance. The third-stage nozzles incorporate axial tubes which direct cooling air on to the forward face of the free power turbine. The latter is forged integral with its shaft, and it incorporates blades with extended fir-tree roots, between which are mounted light, fabricated boxes which seal the inter-root spaces and serve as dampers. [*Contd. overleaf*



1 Starter dog
2 Accessory-drive carbon seal
3 Accessory-drive assembly
4 Overhung Stage 1 disc
5 Starter cables
6 Balance-piston air pipe
7 Stage 2 disc and compressor forward shaft
8 One-piece compressor spool
9 Hydraulic (fuel) actuator
10 Ball thrust centre-bearing
11 Forward entry diffuser
12 Sixth-stage air to cool power turbine
13 Oil feed to No. 3 bearing and power turbine
14 Compressor rear frame
15 Stage 1 cooling plates
16 Forward turbine shaft
17 Turbine tie shaft
18 Holes for turbine-disc cooling air
19 Curvic coupling
20 Power-turbine temperature sensor
21 Emergency overspeed governor
22 Reduction-gear breather
23 Power take-off
24 Reduction-gear oil pump
25 Reduction-gear drive coupling
26 Reduction-gear mounting flange
27 Exhaust air from Stage-1 nozzles
28 Worm-drive to 30
29 Holes for turbine-disc cooling air
30 Flexible shaft for power-turbine governor
31 Power-turbine tachometer
32 Anti-swirl impeller for disc cooling air
33 Fuel control unit
34 Annular dovetail root fitting
35 Pilot valve for variable-incidence actuator
36 Fuel pump
37 Balance-piston air seal
38 Inner location for I.G.V.s
39 T_1 sensing tubes for control system
40 Accessory gearbox
41 Carbon seal compressor/accessory bus
42 No. 1 bearing (roller)

This cut-away drawing of the Gnome has been prepared by an artist of de Havilland Engines, Ltd., and it reveals most of the major characteristics of the engine. An American cut-away of the General Electric T58 was published in our issue of January 17.

A close-up of part of the second-stage turbine nozzle assembly. Of particular interest is the honeycomb type seal, employed in the inner face, which has been found extremely effective. S.521 steel is the material.

GNOME . . .

DE HAVILLAND GNOME

(Basic data for bare engine without reduction gearbox)

Dimensions: Overall length, 54.8in; width, 18.2in; height, 19.6in; diameter across mountings at intake, 12.36in.

Weight: Dry weight, 275 lb (350 lb with gearbox).

Performance: Maximum power (one-hour rating), 1,000 s.h.p. at 19,500 output r.p.m. with s.f.c. of 0.65, compressor turning at 26,000 r.p.m., passing 12.4 lb/sec at pressure ratio of 8.3; max. continuous, 900 s.h.p. with s.f.c. of 0.67; 90 per cent power, 810 s.h.p. with s.f.c. of 0.70; 75 per cent power, 675 s.h.p. with s.f.c. of 0.75.

Although the gearbox is, at 75 lb, heavy in relation to the remainder of the engine, it is extraordinarily light in view of its transmission of 1,000 s.h.p. through a reduction ratio of 3.25 : 1. The casing is magnesium alloy, and sleeve bearings retain the double helical spur gears. The complete casing can be mounted to project directly upwards or to the left or right, the curved exhaust trunk correspondingly pointing in the opposite direction.

There are no particularly unusual features in the lubrication system. The main pump is of the gear type and it comprises one pressure and four scavenge elements. The scavenge pumps serve the following areas: front compressor bearing and accessory gearbox; rear compressor bearing (via external pipes); gas-generator turbine bearing; and power turbine bearing. The oil is cooled by a fuel/oil heat exchanger which obviates the air cooling problems sometimes met in hovering helicopters. A high-energy ignition system is employed, the capacitor discharging through a single surface-gap igniter. The fuel system is relatively straightforward and comprises a centrifugal filter, pump, fuel control, fuel/oil radiator, flow divider, manifolds, nozzles and assorted piping and drains.

Essentially the control system is intended to maintain a selected output r.p.m., to prevent overspeed, compressor stall, excessive temperature, rich or weak extinction, to govern the idling speed of the gas-generator and to schedule the incidence of the variable blading to provide the correct airflow. In the basic T58 a hydro-mechanical system by Hamilton Standard is employed, which during normal operation maintains the selected output r.p.m. regardless of the power required (up to the maximum of which the engine is capable).

At the present time General Electric have logged well over 10,000 hours on the T58. The basic helicopter engine originally sponsored by the U.S. Navy has successfully completed a 150-hr U.S. Model Test and is now in production for all American Services. The engine has flown in the S-58, Vertol H-21 and 107 and Sikorsky S-62, and its first production applications are the U.S. Navy Kaman HU2K, and the Sikorsky S-61 helicopter in which two T58s are geared to a single five-blade rotor.

A pair of development engines were received from G.E.'s Small Aircraft Engine Department in June, both of which corresponded to an early form of the T58-GE-2. An extremely neat test bed for the Gnome has been prepared at Hatfield, using an original Ghost bed as a basis, and calibration running of one of the American engines is imminent. Orders for the Gnome have yet to materialize, but de Havilland obviously expect both the British armed forces and commercial operators to choose an engine which they believe represents an unrivalled combination of outstanding performance and proven reliability.

ACCESSORIES AND MATERIALS

As a basic policy, de Havilland Engines will make as much of the Gnome as possible themselves. Major accessories, however, will obviously be shared between many other companies and, although the following list is neither complete nor final, it indicates companies which may be concerned:—

Fuel system, Dowty Fuel Systems, Joseph Lucas (G.T.E.) or D.H. Propellers; igniter 3-joule capacitor box, Rotax or B.T.H.; igniter plug, K.L.G.; electric starter, Rotax or B.T.H.; oil system, D.H. Engines; flexible pipes, Aeroquip or Palmer.

Materials: compressor spool, shafts and blades, basically Rex 448, heat-treated to a D.H. specification to 65-75 tons; stator blades, S.61 steel; air intake, D.T.D.735 aluminium alloy; accessory box, D.T.D. 748 Elektron ZRE.1; combustion casings, Rex 448; flame tube, Nimonic 75; turbine discs, Rex 448 (D.H. 236); gas-generator turbine rotor blades, Nimonic 90 both stages; power turbine rotor blades, Nimonic 80A; turbine nozzle blades, Stellite X.40; nozzle assembly, Nimonic 75; turbine shrouds, Rex 448; shroud segments, D.T.D. 176; spherical bevel gears, S.107 steel; spur gears and shaft, S.98 steel; exhaust duct, Nimonic 75; reduction gearbox, D.T.D. 748 (ZRE.1); helical gears, Nitralloy N; other gears, S.107 steel; seals, "Sealol" units manufactured by Flexibox.

THE INDUSTRY

Under an agreement between Easco Electrical (Holdings), Ltd., and Plessey International, Ltd., the latter company now handles all overseas sales and enquiries for Eascolyte low voltage fluorescent lighting equipment. Developed jointly by Easco Electrical and the Plessey Co., Ltd., it will continue to be marketed by Easco in the United Kingdom.

* * *

Aerolex, Ltd., of Camberley, Surrey, have published a particularly informative loose-leaf catalogue giving technical data on their products, which include a variety of freight-lashing equipment, buckles of many different types for clothing and aircrew harness, and seat belts and straps. A praiseworthy point is the clarity of the illustrations, which consist of perspective line-drawings, dimensioned where necessary.

* * *

An agreement has been reached between Armstrong Siddeley Motors, Ltd. (a member of the Hawker Siddeley Group), and Beaver Precision Products, Ltd., of Detroit, Michigan, U.S.A., under which both firms will co-operate in the complete interchange of technical knowledge and manufacturing techniques in respect of the American company's products. Beaver Precision Products are among leading U.S. designers and manufacturers of ball screws, ways and splines, used extensively as precision actuating mechanisms in missiles, aircraft, machine tools and instrument production. Under the agreement a new division, to be known as Beaver Products Division, is to be established in this country by Armstrong Siddeley Motors, Ltd.

* * *

Mr. P. S. Aked, formerly deputy chief test pilot of Armstrong Siddeley Motors, Ltd., has been appointed executive pilot for the United Steel Companies, Ltd., Sheffield, who are to operate an aircraft based on Ringway.

Racal Engineering of Bracknell recently gave an informal reception at the Savoy Hotel, London, for delegates to the British Joint Communications and Electronics Board conference. Among those present were A. Cdre. H. G. Leonard-Williams (left), Director of Signals (1), Air Ministry, and Air Marshal Sir Raymond Hart, Controller of Engineering and Equipment, Air Ministry. The firm announced that over a thousand of their RA.17 receivers have now been sold; examples of this and the new TRA.55 radio telephone were on show.

Straight and Level

I MUST place on record my admiration for Russian helicopter designers. I do not know of their failures —if any—but I do know that their successes have *consistently* been the best in the world. When we first saw the Mi-1 we thought it was a copy of the S-51 or Sycamore. When we first saw the Mi-4 we thought it was a copy of the S-55. And when we saw the Yak-24 we thought it was a nasty offshoot from the Bristol 173. How wrong we were.

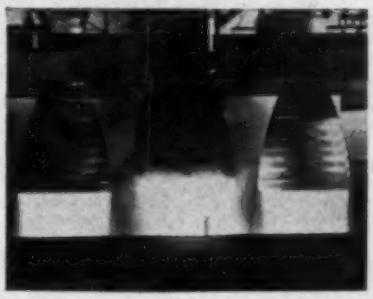
All of them have far more power than their Western counterparts, and power is one of the stepping-stones to rotary-wing success. All have bags of room and easy access. All have four-blade rotors, like those we are now getting round to. All are easily maintained, fly well, have all-weather equipment and look like lasting for years. And all are in service in hundreds, if not thousands. Moreover, the Soviets—and Kamov in particular—have even showed that the co-axial configuration can be made to work.

Five years ago I thought the Americans were leading the rotary-wing world. But, except in the smaller sizes, they now seem to have fallen a little flat. In fact, they even seem to be letting Russia —and Britain—teach them how to make big helicopters work.

● Dare I say that the days are gone for ever when nobody does anything without a nice, juicy, fat M.o.S. contract to pay for it? At one time things got to such a pitch that companies were quite prepared to spoil million-pound ships for the proverbial ha'porth of tar, just because the source of wealth was not prepared to shell out for some trivial modification. Today the British industry really does appear to be biting off just as much as—and no more than—it can chew, and then getting down to digesting it. If an M.o.S. research contract comes along that will be fine—says each Board of directors—and in the meantime everybody assumes that one won't and plans accordingly. And that's fine, isn't it? Isn't it?

● I hear, by the way, that the Air Ministry is sending R.A.F. stations a new-style hat for W.R.A.F. acceptance trials. I hope the resultant millinery will not be as ghastly as was the outcome of previous trials. What's wrong with the trim blue beret I seem to remember being worn so fetchingly by the wartime W.A.A.F.?

● People who read this journal may sometimes feel surfeited with discussions about jets, props, differential fares, routes, finance and all the thousand-and-one things that go to selling airliners. Those of us who can watch the various struggles from the touch-line are fortunate. The players find it the sort of life that separates the men from the boys in no uncertain manner. Once in, a manufacturer is utterly committed. Vickers, for instance, have a big turboprop and an even bigger jet. They will not drop either; they will not greatly change either; they cannot greatly accelerate either; if one of them isn't what the customer wants that's just too bad. And the same goes for everyone else. Come to think of it, it's almost as tough for the operator.



● There are two ways in which I might describe this picture. I could tell you that it is the business-end of a Convair Atlas ICBM on captive test; that the centre (sustainer) engine is delivering 65,000 lb thrust, and that the outer boost motors are delivering a cool (5,880° F) 165,000 lb each.

Or I could tell you that this is something more than Man's latest bow-and-arrow: it is the weapon to end all weapons, and—I sincerely hope—to end all world wars. With other ballistic missiles it has cost the American taxpayer about $1,000 millions. The notice on the wall of the test-cell reads No Smoking.

● Announcement of the Britannia 320 and the Vanguard Mk 2 sorely tries my patience with the nomenclature of British civil aircraft. It is wearisome, obscure, esoteric, and quite unnecessary.

The Bristol Britannia 320 is an improved long-haul Britannia, and good luck to it. But eighteen months ago it was a "specialized" short-haul Britannia. And not long ago it was the number reserved for the ninth purchaser of the 310, formerly known as 300LR, and, of course, not to be confused with 300, 302, 305, or 307.

The Vanguard Mk 2 is an improved Vanguard, and good luck to it also. But what is the Mk 1, and how is it related to the 951 and the 952? And why do Vickers introduce mark numbers for the Vanguard when they have never done so for the Viscount? (I am, however, relieved to hear that Vickers will probably not insist on the designation Mk 2.) But the Viscount's system had me lost in its labyrinths long ago. Apparently Continental Air Lines of Denver got lost too. Their aircraft were designated 812, which is the same as 810. (This last number, according to the system, is reserved for the tenth purchaser of the 800, a Viscount which is, however, as different from the 810 as the 700D is from the 700.)

Anyway, Continental have swept official nomenclature aside, and painted "Viscount Mk II" on their aircraft, which is much better from the sales-promotion point of view.

I agree that drawing offices and contracts and specification departments need detailed nomenclature systems. But they should not inflict them on the outside world. What is wrong with 1, 2, 3 for type developments, and A, B, C for type variants? This is the D.H. system, and it seems to work all right. Here is a crying need for standardization, and I commend it to the attention of the S.B.A.C.

● Talking about Continental Air Lines, *and* about the standardization of nomenclature, I notice that this respected airline has not yet decided how to write its own name. On all the company's published matter the name appears as three words. But on its Viscounts it appears as two—Continental Airlines.

● According to Air Marshal Sir Richard Atcherley, the ballistic missile is "just a sophisticated shell." And, he went on, "nobody ever won a war with a sophisticated shell."

He is right, of course; for the limited war and the total war the manned bomber will be needed for as far ahead as anybody can see. But we must take care to guard against the tendency to decry something we haven't got, and then laud it to the skies as soon as we get it. Britain has made this mistake too often.

● It is a fact that B.O.A.C. are the third largest carrier of traffic between North America and Europe. First comes PanAm, second T.W.A. The Corporation have held this position for eight years, and look like maintaining it.

I think this is a fine thing—especially as B.O.A.C.'s traffic is only to and from the U.K.; the Corporation has none of PanAm's or T.W.A.'s European gateways. I just mention this in case anybody does not know about it, because for one moment last week I thought that B.O.A.C. themselves were not sure.

● There are lots of good cracks attributed to A. Cdre. G. A. ("Gus") Walker, the energetic A.O.C. of No. 1 Group, Bomber Command. One of the latest: "Don't mention the word nuclear—it's dynamite."

ROGER BACON

CORRESPONDENCE

The Editor of "Flight" is not necessarily in agreement with the views expressed by correspondents in these columns. The names and addresses of the writers, not for publication in detail, must in all cases accompany letters.

What to do with Three Jets

I HAVE pleasure in crossing literary pen and drawing pencil (and slide-rule, too!) with that learned member of *Flight's* technical staff who wrote anent the Airco D.H.121 on page 120 of your superb Commercial Aircraft issue of July 25 that: "it [the afterbody tri-engined installation] was also virtually obligatory, since no other practical position exists for a tri-engine scheme." Not so, Sir! There may be obligation (to the point of obeisance) to B.E.A. thinking, but I can see no virtue whatever in this unimaginative layout.

Without straining my elbow beyond stretching for my doodle pad, I can think of a much more logical and aerodynamically superior tri-jet configuration: locate the two Junior Conways fully submerged in the wing roots and place the third engine, also fully submerged, well aft of the rear cabin bulkhead and aspirated via side intakes. It almost goes without saying—in 1958 for a 1964 airline vehicle!—that the two wing-root engines would have flattened out tail-pipe propulsion nozzles producing a ribbon-shaped efflux exhausting through split-type trailing-edge flaps over the inboard third or so of the wing span; that is, a simple, practical, half-way approach to jet flapping. And I do wish to emphasize the *practical*.

Consider the obvious advantages: (1) A clean lift mechanism, with partial jet flap, yielding shorter take-off—generally the critical jet performance parameter of today and tomorrow. (2) Lower landing speed and shorter landing run, due to higher maximum lift coefficient in a "power-on" landing. (3) Lower noise level from ribbon-type jet efflux (cf. Convairliner experiments with flat rectangular exhaust pipes) and possible elimination of thrust-blockage "cabbage-type" noise suppressors, along with their extra weight and drag. (4) Elimination of fatigue-hammering of fuselage caused by expanding gas stream from conventional circular nozzles of wing-root engines close to fuselage sides. (5) Easier accessibility of rear centre engine unencumbered by proximity of outer pair. Accessibility of the two wing-root engines is no more difficult than that of the externally podded rear pair. (6) Better (more concentrated) mass distribution of powerplant weight resulting from location of the two wing-root engines close to aircraft c.g. (7) Cleaner, more efficient, tail design, with the horizontal tail located about one-third way up the vertical fin surface. (8) Appreciably lower total aircraft drag, and hence higher lift/drag ratio, with resulting performance gains and lower operating cost. This most significant design desideratum seems to have been lost to view.

Why copycat French (or American) aerodynamic fashions, when the original British jet engine installation concept, imaginatively modified in the light of current engine-airframe integration thinking (stemming from jet-flap research), is far and away superior on *all* counts? In the D.H. Comet, Vickers Valiant and V.1000, Avro Vulcan and H.P. Victor, we exhibited jet imagineering on the board as well as in the board room. Let's cock a snoop to fate and recover the lost faith in ourselves!

Santa Monica, U.S.A. HOMER IN EXILE.

"All these were honoured . . ."

PLEASE allow me to congratulate you on the series of drawings by Leonard Bridgman now appearing in *Flight*. Long may they continue to bring a breath of flying as it used to be. They lack only one thing—colour. However, we must be thankful for these as they are.

Christchurch, Hants. K. W. MARSHALL, late R.A.F.

Poole Petrel

I AM naturally most interested in the letter from Mr. K. W. Clark (*Flight*, July 25) identifying the ugly duckling as the Petrel. My memory is that it "just growed," after which about six weeks were spent in rigging and tuning it. Then one day in summer it took about two-and-a-half miles to unstick; when it did, it wallowed up to about 200ft and then flopped back into the water. Subsequently it did much better. The explanation of "Wilbur Wright's first flight," as one of the naval people called it at the time, is provided in the letter. The span was about 25ft, length about 18ft, height about 10ft. Powerplant was a radial of about 250-350 h.p. The main float was held by six nearly vertical struts in pairs and the tip floats by large vee-braces. The vee-braces for the main float almost met those of the tips. A large generator was held in a strut under the port centre section. I have no record of any serial number. The inference is that, having been tamed, the bird was lost with the submarine *Surcouf*.

I have a note upon this to the effect that a convoy had *Surcouf* (whose crew had fought below decks with small arms on a Vichy *v.* De Gaullist basis) as part of the escort. Ships were sunk with nothing to indicate an enemy. The torpedoes were eventually traced to *Surcouf*, which was then sunk by our own forces. Nothing I can find provides any confirmation, but there are a number of unpleasant things still covered by the war. The submarine was one of the largest ever built: 4,300 tons submerged. In 1929 it was very advanced, with ten 21in torpedo tubes, two 8in main armament and two 37 mm A.A. The aircraft was housed in a hangar at the after end of the conning tower. Its performance was comparable to that of the Parnall Peto, similarly designed for the R.N. M-class submarines.

Poole, Dorset. JOHN GAYLARD.

Aircraft Electrical Systems

AT the risk of being witless about what's watt and what's wattless, I find it hard to see how two identical alternators running connected to the same busbar can have different output voltages (*vide* Mr. Lionel G. Hill's article on electrical systems in *Flight* of August 1). If one has full excitation and low power (h.p. or kW) input from the prime mover, and the opposite applies to the other, the shareout of both the kilowatt and reactive loads between the machines will be very far from equal.

London, S.W.1. T. B. ROLLS.

The Grade Monoplane

IN the past few weeks some letters from readers have appeared in your columns concerning the Grade monoplane, which had undercarriages both above and below the fuselage.

This aeroplane was used for aerobatic flying at the Hans Grade aerodrome near Berlin (Bork) during June and July 1914 and was flown by Tweer, Jahn, and Küppers. The undercarriage on top was most probably fitted in case a pilot became inverted and was unable to "get right way up" before landing.

On several occasions the above-mentioned pilots landed this machine in the inverted position.

Berlin-Charlottenburg 2. WILLI STIASNY, Archiv für Fluggeschichte

[We had not intended publishing further letters on this subject—more have been received, from various parts of Europe—but Herr Stiasny's contribution is of particular interest in view of its definite mention of inverted landings—Ed.]

Upstart Words

IN Roger Bacon's admirable paragraph ("Straight and Level," July 11) about unnecessary verbiage in American writing, an echo will surely be found in many minds. But there is also the menace of ugly, upstart words to which the United States has introduced us in recent years. What about "transportation"? In the Concise Oxford Dictionary the word "transport" appears to cover "transportation," so why not use the former, since it is just half the length? I do not believe that *Flight* has often used this elephantine word, but it does seem to be spreading.

Of course, we have all read many other bastard words which seem to owe their origin to our American cousins—"miniaturize," "debarking" and "disassembling" are just three examples that occur to me "as of now." The English language, which the Americans have been good enough to use for some time now, is a very flexible one, and rightly so; but some coined words are so "uneuphonious" that one instinctively recoils from them.

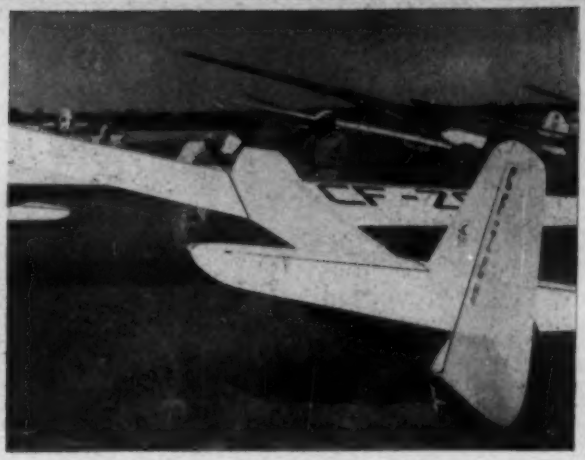
Great Bookham, Surrey. PAMELA POWELL.

CORRESPONDENCE IN BRIEF

A reader recalls seeing, in "a good-circulation U.K. magazine" about eight months ago, a digest of a book on the Alcock and Brown transatlantic flight. He is anxious to identify the journal and the date of the relevant issue. Letters (addressed "'Cri de Coeur,' Correspondence, August 15, c/o The Editor") will be forwarded.

FORTHCOMING EVENTS

Aug. 16-17. Alsace Aero Club: Rally des Vins, Alsace.
Aug. 24. Luton Flying Club: Display.
Aug. 31. Oxford Aeroplane Club: At Home, Oxford Airport.
Sept. 1-7. S.B.A.C. Display and Exhibition, Farnborough.
Sept. 4-6. AGARD Avionics Panel Meeting, Cambridge.
Sept. 8-13. International Congress of Aeronautical Sciences, Madrid.
Sept. 21. B.G.A.: National Sailplane Aerobatic Contest, Dunstable.
Sept. 21. Royal Belgian Aero Club: 900 cu m Balloon Competition.
Sept. 21. Milan Aero Club: Rally.
Sept. 26-29. Austrian Aero Club: Innsbruck Rally.
Oct. 20-29. AGARD meetings, Copenhagen.



"Flight" photographs

Above left, the first contest launch of the 1958 Canadian National Gliding Championships—notes on which appear below—was that of the Slingsby Skylark 3 flown by Eric Best, president of the Southern Ontario Soaring Association. Above, members of the all-German Harmonie Club with their Bergfalke two-seater. Extreme left, Leo Smith, president of the Soaring Association of Canada, the national organization which now has 17 member clubs. Left, competition pilots Frank Brame, Bruce Cooper, Jim Carpenter and Eric Best. A feature of the contest was its division into two separate weeks, with a final fly-off between the leading pilots in the two heats.

Club and Gliding News

CANADA'S GLIDING CHAMPIONSHIPS

THE steadily increasing popularity of gliding in Canada has been clearly demonstrated during the past month at Brantford Airport, Ontario, where the Canadian National Gliding Championships are now drawing to a close. Also obvious this year was the increasingly high standard of competitive gliding in the Dominion.

The above *Flight* photographs of the contest were taken recently by Kenneth Owen during a visit to the Southern Ontario Soaring Association, Brantford's resident club and (under the sanction of the Soaring Association of Canada) sponsors of the meeting. This year's contest has been organized in two separate weeks, July 20-26 and August 3-9, to cater for pilots whose participation must coincide with company holidays, with a final fly-off between the respective leaders during the weekends of August 16-17 and 23-24.

The Soaring Association of Canada has a membership of 17 clubs, with a total of approximately 400 pilots. While the eastern clubs, catering for members in the Toronto, Ottawa and Montreal areas, have in the past formed the core of the Canadian gliding movement (all the Canadian pilots in the last three world championships have come from Brantford), there is now a wide network of active groups right across the country.

These clubs are located at Quebec City, Trois Rivières, Montreal (including groups at McGill and Canadair), Ottawa (Gatineau G.C.), Buckingham (St. Michael's Boys High School), Kingston (Queens G.C., with members mainly from Queens University), Brantford (Southern Ontario Soaring Association), Winnipeg, Gimli (R.C.A.F.), Regina, Calgary, Pincher Creek (80 miles south of Calgary), Edmonton, Cold Lake (R.C.A.F.), Vancouver (Soaring Council of British Columbia), and Victoria and Nanaimo on Vancouver Island.

In parallel with increased club and competition activity, a healthy amateur-construction effort is now a part of the Canadian gliding scene. At the Gatineau club at Ottawa, for example, two sailplanes are currently being built. One is a Harbinger two-seater (another Harbinger was recently completed in England) and the other a modified Fauvel AV.36. Leo Smith, who is building the Fauvel, is this year's president of the Soaring Association of Canada.

The aircraft entered for the championships at Brantford included a majority of Schweizer 1-23s and 1-26s (including visiting machines from the U.S.A.); and a trio of Slingsby Skylarks—a Mk 3 from S.O.S.A. and another from Gatineau, and a Mk 2 from Montreal. Among the contestants were Canadian world-championship pilots Charles Yeates and Gordon Oates (1958), Frank Brame and Jack Ames (1956) and Al Pow (1954); and a good number of ex-members of U.K. gliding clubs, including Paul Smith, Bernard Palfreeman and Bob Gairns (Montreal). Members of the club at Brantford include C.F.I. and contest manager Jim Joss (ex-Coventry); instructors Alan Cronin and Dick Bellinger (both ex-Lasham) and George Scarborough (ex-Dunstable); and Peter Folkes of Coventry, Davey Parsey and Frank Anderson of Southdown, and Dave Spicer of Dunstable.

The national contest is divided into an individual class and a team class. In order to provide equal opportunity for all Canadian pilots, including those unable to compete in the championship, the Canadian national champion for the year is chosen not on the results of this meeting but on the basis of a pilot's five best flights during the year.

The 1958 championships are the tenth to be held. Last year's meeting proved especially successful, with six out of seven sailplanes completing a 192-mile goal flight to Elmira, N.Y., on one of the contest days. The final results of this year's contest have not yet been decided, but it is clear that last year's high general standard of performance has been maintained.

A PARADE of veteran cars is expected to form part of Luton Flying Club's display on Sunday, August 24. Aircraft events will include aerobatics by a Jet Provost, the Tiger Club, and a sailplane; there will be a helicopter demonstration, and prizes will be awarded for time of arrival, Concours d'Elegance, and the longest distance flown to Luton.

BLACKPOOL AND FYLDE AERO CLUB are now operating a Thruxton Jackaroo, described in the club's current newsletter as "about the nearest thing to a Ford 8 on wings." Club aircraft are now using Middleton Sands again, and it is planned to reopen the clubroom in the hangar there in the near future.

PROTOTYPES of two new Cessna aircraft are now flying. They are the Model 150 two-seater, orders for 600 of which have been placed by the firm's distributors; and the Model 210, which is said to incorporate "new design features not previously used on a commercial single-engine airplane."

PUBLIC attendance was strong at Sutton Bank on August 4 for a display of gliding given by the Yorkshire Gliding Club. The highlight of the display, which included individual flypasts by a Tutor, Kite 1 (Newcastle Club), Kite 2, Sky, Skylark 1, Swallow, T.21B and T.21C, was a race of six laps over a triangular course with turning points at Roulston Scar, Sutton Bank and Lake Gormire. Five sailplanes took part, a Sky, Skylark, Kite 2, Swallow, and the Newcastle Gliding Club Olympia, and the winner was Chris Riddell in his Skylark 1. Also included in the programme were aerobatics, a height-judging competition and passenger flying in the two T.21s. The second prototype Slingsby Swallow was flown during the afternoon, and Mr. Slingsby himself visited the site in the evening.

One of the last acts of No. 1 Sqn. (then commanded by S/L. R. S. Kingsford) before the recent handing over of its Standard to No. 263 Sqn. at Tangmere was to repeat the squadron's traditional tail-to-tail line-up with its Hunter F.5s. This pose was first photographed at Clairmarais, near St. Omer, in July 1918 (see picture below), when No. 1 was equipped with S.E.5As.

SERVICE AVIATION

Royal Air Force and Naval Flying News

Senior Appointments

COMMANDER of Task Force "Grapple" since December last year, A.V-M. John Grandy is to be succeeded in that post by A.V-M. T. A. B. Parselle and will become A.C.A.S. (Operations) in November. A.V-M. Parselle is to take up his new post in the Pacific next October and will be succeeded in September as Commandant of the R.A.F. College, Cranwell, by G/C. D. F. Spotswood (with the acting rank of air commodore).

A.V-M. Grandy took the 1957 I.D.C. course before his last command, and prior to that was Commandant of the C.F.E. During the Battle of Britain he commanded No. 249 Sqn. and later in the war flew on several hazardous sorties in Burma, being awarded the D.S.O. He is also a C.B.

A.V-M. Parselle has been A.O.C. and Commandant of the R.A.F. College since April 1956 and prior to that was for two years in Australia as Commandant of the R.A.A.F. Staff College at Point Cook on an exchange posting. When commanding No. 207 Sqn. during the war he was shot down during an attack on Dusseldorf in 1943 and taken prisoner, being repatriated in 1945. He is a C.B.E.

G/C. Spotswood has been Deputy Director of Plans at Air Ministry since October 1956 and in June 1953 was appointed an Aide-de-Camp to the Queen. He won the D.F.C. in November 1942 when commanding No. 500 Sqn., equipped with Hudsons, on anti-U-boat operations; and the following year he was awarded the D.S.O. He is also a C.B.E.

Far East Surveyors

EQUIPPED since 1946 with Spitfires, Mosquitoes and Meteors, No. 81 (Photographic Reconnaissance) Squadron (S/L. R. J. Linford) has just completed ten years of photographic operations in Malaya, during which it flew 8,958 operational sorties supporting ground forces. In addition its aircraft carried out routine survey work in many parts of the Far East, covering 49,000 square miles of territory.

A famous wartime fighter squadron, it changed its rôle on going to Singapore in September 1946. From Seletar, and with a detachment in Java, it began an aerial survey. The Java survey was completed in three months and a detachment then went to Burma, to survey western Thailand, while in Malaya No. 81's aircraft undertook a special survey of bandit-infested regions for the police. In July 1948, when the Malayan state of emergency was proclaimed, the squadron was based at Tengah.

On July 9, 1948, one of the squadron's Spitfires made its first operational flight in direct support of the anti-terrorist land forces. Three months later its Mosquitoes began an emergency survey of Malaya, completing it by August 1950. Its basic photographic cover of Malaya was finished in September 1953. The squadron had a detachment of two Spitfires and then two Meteors at Kai Tak (Hong Kong) from 1953 to 1955. In Malaya, in November 1953, Mosquitoes replaced the Spitfires, the last operational Spitfire sortie being made on April 1, 1954, by S/L. W. P. Swaby, then commanding. On December 15, 1955, the last Mosquito flight was made and Meteors took over.

In the Far East from 1953 to 1955, Mosquitoes had borne the largest burden of aerial photography, carrying out many long-range flights in Ceylon, Car Nicobar and Christmas Island (in the Indian Ocean), Thailand, Indo-China, Burma, Borneo, Labuan, Sarawak, the Cocos Islands, the Philippines and Japan.

Unusual tasks often came the way of No. 81. In Borneo, authorities engaged on anti-piracy work once asked the pilots to report any suspect vessels they might see. One pilot radioed the position of a likely craft and the Borneo police netted a boat-load of pirates. The squadron also photographed the disastrous Singapore floods of December 1954, and in 1955 the damage caused there by rioting.

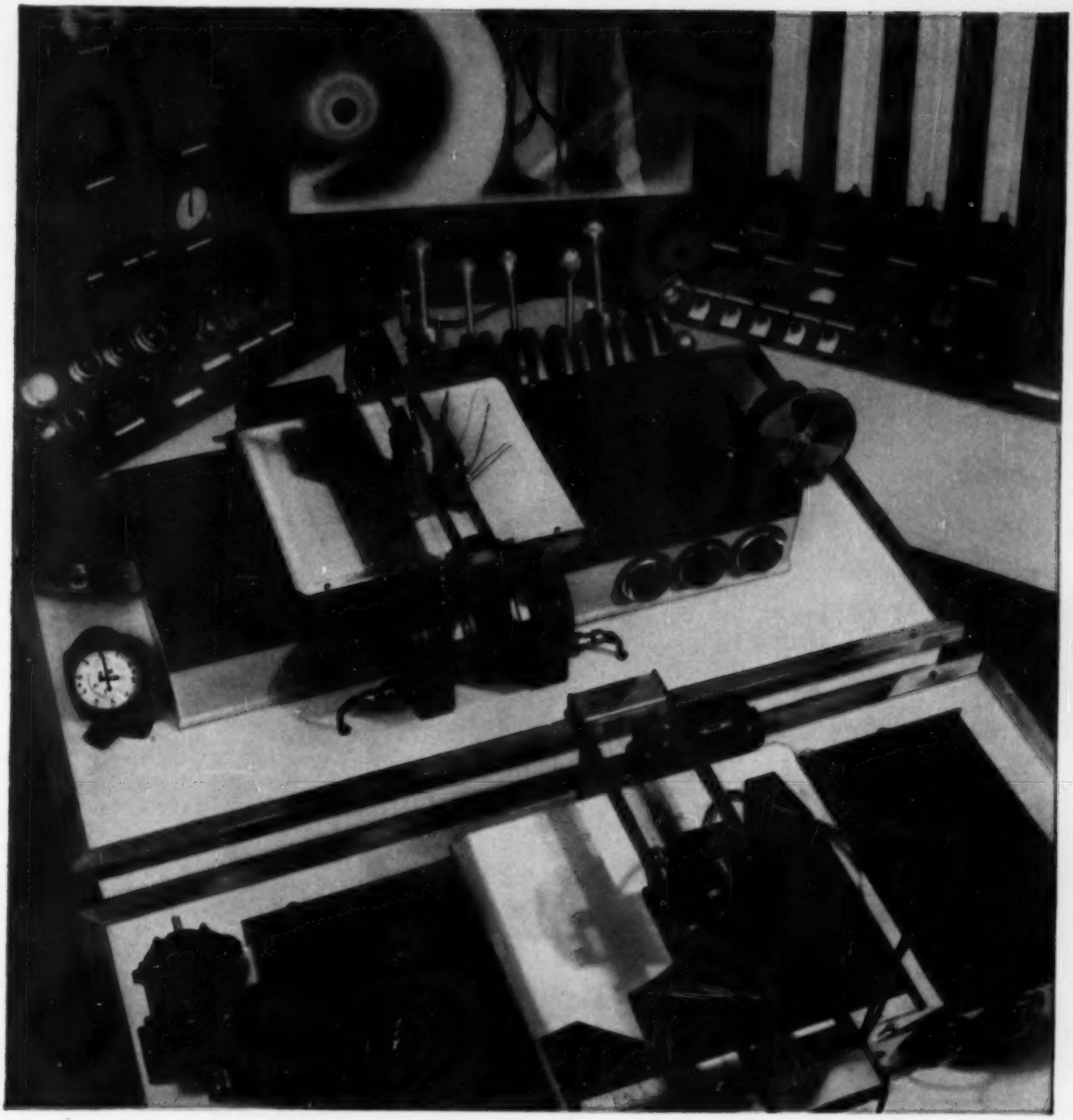
Battle of Britain Service

A SERVICE of Thanksgiving for the victory achieved in the Battle of Britain in 1940 is to be held in St. Paul's Cathedral on September 21, at 3.15 p.m.

Applications for tickets for the service should be sent in writing to the Under-Secretary of State, Air Ministry (S.4c), Whitehall Gardens, London, S.W.1, not later than September 5. (Applications should not be sent to the Cathedral authorities.) First consideration will be given to widows and bereaved parents of Battle of Britain aircrews, and to retired R.A.F. officers and Battle of Britain pilots who wish to attend. The service is not being held in Westminster Abbey this year owing to cleaning operations in the Choir.

The first tail-to-tail group posed, in 1918, by No. 1 Sqn. (see above). When this photograph was published in "Flight" for August 1, 1918, the caption had obviously suffered under the severe censorship of that period; it simply read: "A squadron of scouts on the British Western front in France, where they have been doing first-class work."

One advertisement in a series of nine



LUCAS RESEARCH

LUCAS uses its *Sea Level Engine Test House* for development-testing new fuel system designs — before prototype manufacture.

For this testing unit Lucas designed and built two instruments which are unique in Europe. One taking a transient function from the engine and scheduling a pre-determined fuel flow, the other recording the phenomena under examination by direct plotting.

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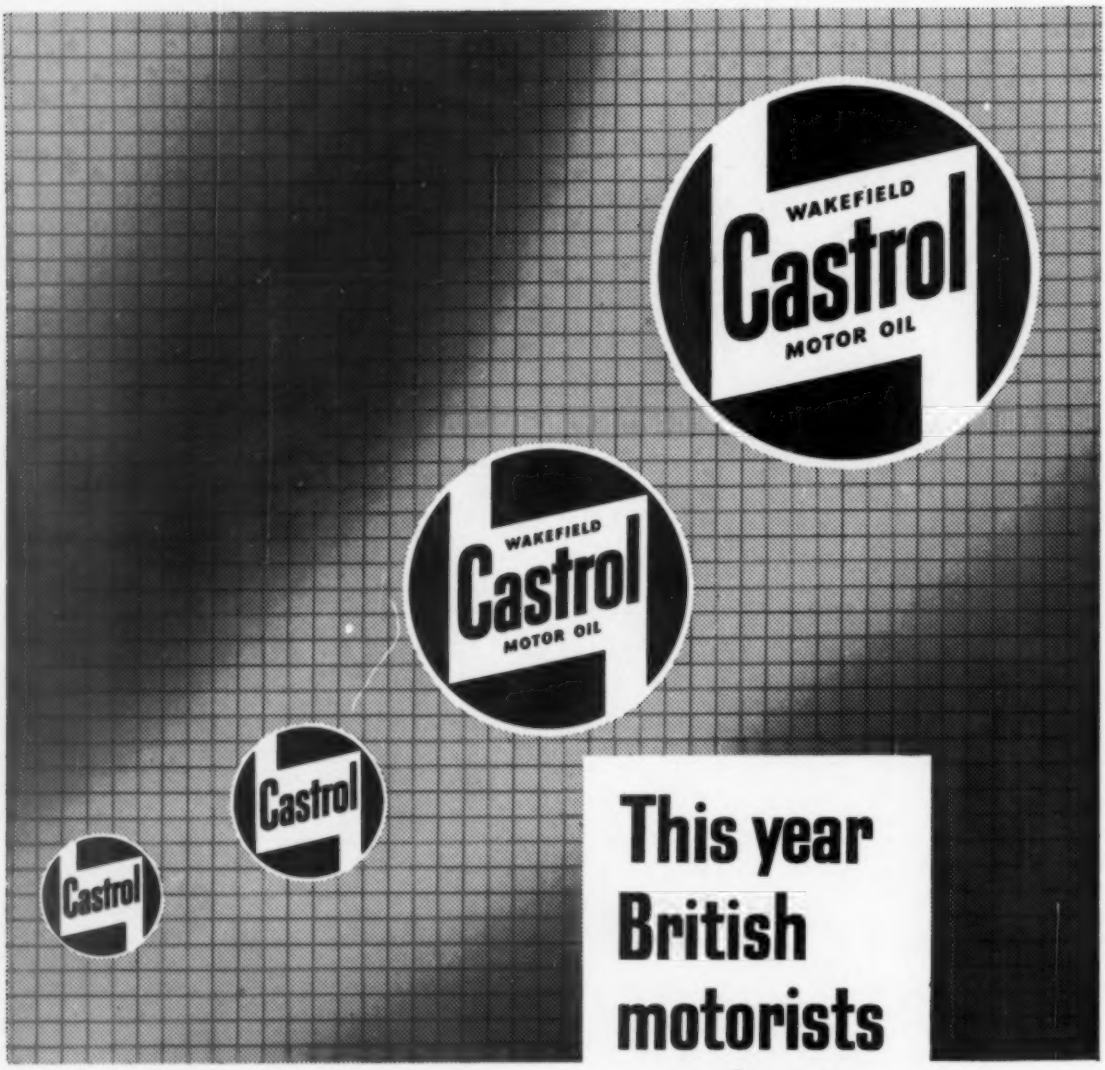


This year British motorists are buying

more Castrol

than ever before!

Castrol is the "Masterpiece in Oils" and approved by every British car maker. Why take a chance with the oil in *your* engine? Always ask for Castrol by name!

SERVICE AVIATION . . .

F.A.A. at Farnborough

SEVEN Sea Hawks from No. 800 Sqn. and four Scimitars from No. 803 are putting on formation aerobatic displays at Farnborough next month as the Royal Navy's contribution to the S.B.A.C. show.

No. 800 Squadron was until last month embarked in H.M.S. *Ark Royal* in the Mediterranean: it started to work up for Farnborough at its shore base, R.N.A.S. Brawdy, on July 21.

The aerobatic routine No. 800 has worked out consists of five manœuvres—a loop in line-abreast formation (five aircraft in line and two in line astern), changing to a vic; a roll in swan pattern; another loop, changing from swan to vic; a roll, moving from vic to double vic; and a third loop and roll, followed by a bomb-burst with the aircraft streaming blue smoke. This spectacular routine is rounded-off by a nine-plane formation landing, in which the two reserve Sea Hawks take part.

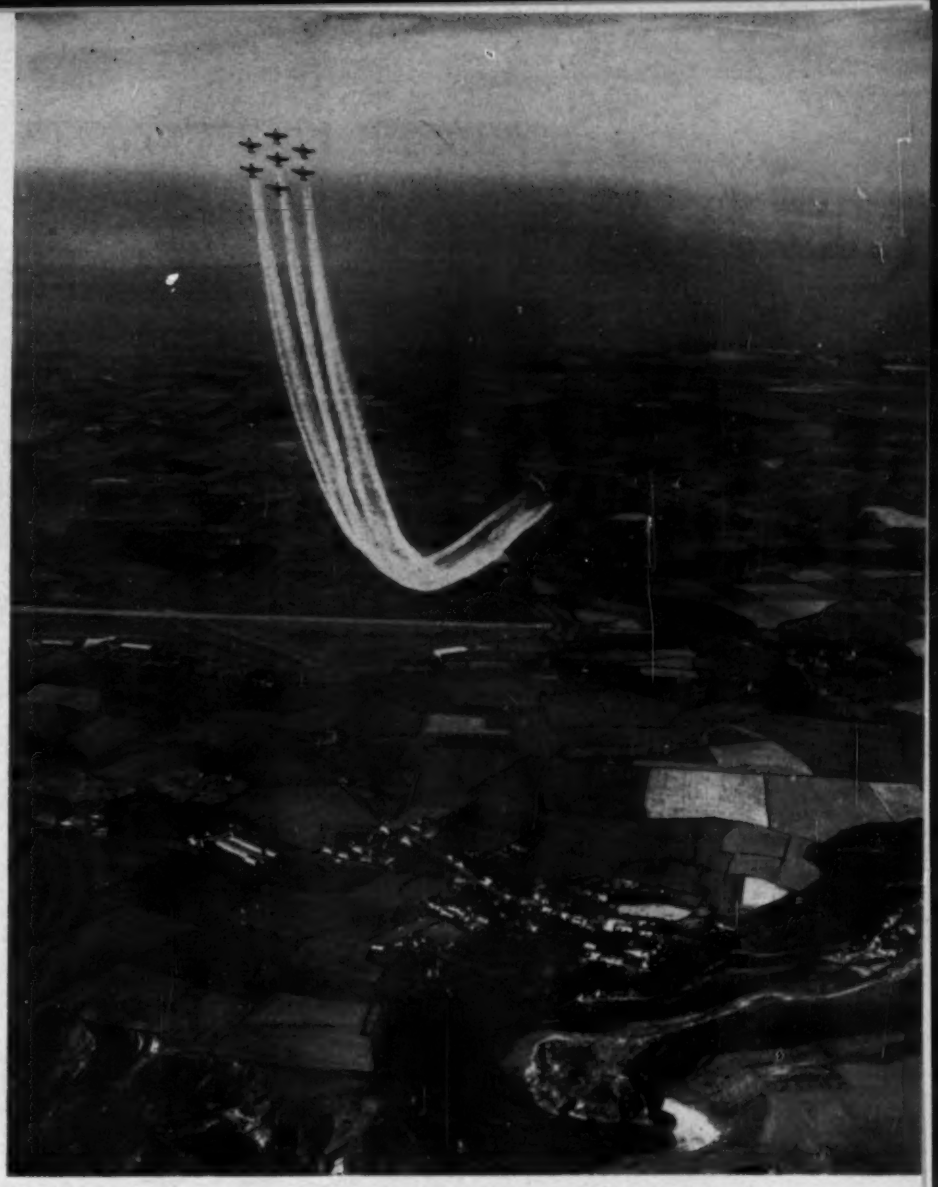
No. 800 is the oldest F.A.A. squadron, having been formed in 1933 in H.M.S. *Courageous*. During the war it operated off Norway, in the Mediterranean, against the *Tirpitz*, and in the Far East.

The squadron's present C.O. is a 38-year-old New Zealander, Lt-Cdr. Norman (Peter) Perrett; he has been in command since October last year and will be leading the formation at Farnborough. No. 2 is the Senior Pilot and Executive Officer, Lt-Cdr. A. A. Fyfe; No. 3 is Lt. Brian Toomey (Air Warfare Instructor); and the other pilots are Lt. D. Pentreath, S/Lt. R. W. D. Westlake and Lts. R. Dimmock and P. R. Miller, with Lt. J. D. H. Weyman and S/Lt. C. R. Cresswell in reserve.

No. 803 Sqn., which was also formed in 1933, was re-equipped with Scimitars in June and has since been working up at Lossiemouth.

The squadron's wartime achievements included the shooting down of the first enemy aircraft—a Do 18—destroyed during the war, by one of the squadron's Skuas.

No. 803 Sqn.'s present C.O. and leader of the Farnborough formation is Cdr. J. D. Russell. The senior pilot is Lt-Cdr. G. R. Higgs and Nos. 3 and 4 in the team are Lts. E. R. Anson and P. J. Barber. The reserve pilots are Lts. J. W. Beard and M. V. Maina.



Sea Hawk 6s of No. 800 Sqn. practising their formation aerobatic routine for Farnborough. In the picture above they are seen over St. David's airfield. These photographs, and those on page 219, are the work of "Flight" photographer Ian Macdonald. "Flight" photographs

Seen over the English coast on a pre-delivery test flight is the first of Northeast's nine Vickers Viscount 745Ds. It departed for Boston on August 9, and with two others will be in service this month on the airline's network to New York, Philadelphia, Washington and Montreal.

CIVIL AVIATION

TOO MANY JETS—

THE question which everyone concerned with air transport has been asking these two years past—"Have the airlines bought too much equipment?"—has now been answered with some authority. The answer is yes, according to a study* by I.C.A.O.'s Air Transport Committee (*Flight*, July 4) which is now generally available.

The study was commissioned at the I.C.A.O.'s Assembly at Caracas in 1956. It has taken about 18 months to complete, but its conclusions were not unanimously accepted by the I.C.A.O. Council at its Montreal meeting last June. As previously reported, the views of the British and American delegates had to be overruled before the study was released. Mr. J. Riddoch of the U.K. considered it was misleading to associate excess capacity with jets, because this was a phenomenon that could have arisen from the over-ordering of any type of aircraft. The U.S. delegate, Mr. Nelson David, opposed publication of the study on the grounds that it would prejudice the airlines' financing plans.

It is thus significant that I.C.A.O., in publishing the study last week, stated: "The Council has not adopted or endorsed any conclusion contained in it . . ."

The study goes further than its title and terms of reference suggest: while it discusses the economic implications of long-range jets, it also undertakes, in unprecedented detail, the exercise of adding the capacity of existing fleets to the capacity of the new fleets on order, and matching the total against anticipated traffic. The assumptions made here are obviously of fundamental importance, and were as follows:—

(1) Average block speed 85 per cent of mean cruising speed; (2) Average payload capacity 80 per cent of maximum; (3) Average utilization eight hours per day for long range jets, seven hours per day for medium jets and turboprops; (4) Present delivery schedules will be achieved; (5) Attrition-rate from accidents, etc., will be two per cent per year (disposal of fleets ignored); (6) Load factor of 58.6 per cent; (7) Traffic increase up to 1961 at 15 per cent per year.

We hope to summarize the "excess-capacity" conclusions in a future issue; in the meantime, examination of a brief I.C.A.O. summary of these conclusions, received last week from Montreal, suggests that they may differ somewhat from the conclusions of an early draft of the study, These were summarized recently in *Aviation Daily*:—

	1958	1959	1960	1961
	(millions of ton-miles)			
Theoretical excess of potential productive capacity over capacity required for 59.4 per cent load factor ...	723	497	2,104	1,611
Maximum capacity that might be sold to non-scheduled operators	172	368	595	855
Theoretical minimum surplus remaining	551	129	1,509	756

It will be noted that the above conclusions are based on a load factor of 59.4 per cent—rather higher than that assumed for the report published now. The original study appears to be more emphatic in its conclusions about over-ordering; however, the difference between the two versions is likely to lie in the degree, rather than the nature, of their findings.

The real meaning of the report is that the world's governments have lent the authority of their judgment to support the widely held opinion that the economic consequences of the jet revolution may be more serious than the airlines had bargained for. In particular, as the I.C.A.O. study points out, the disposal of piston fleets will present the biggest problem; according to the original study the non-scheduled carriers might absorb a maximum of less than 30 per cent of the scheduled excess by 1960, even if they purchase no brand-new aircraft in the meantime.

Of particular significance is the opinion of I.C.A.O. that fare-differentials between jets and propeller aircraft may be necessary. The study says that "Operators might well place a high price on travel in the pure jets, a medium price on travel in the turbo-props, and a low price on travel in piston-engined aircraft; but the unit operating cost of the three kinds of aircraft will probably not be in this order, at least on long stages." It will be interesting to see whether the published edition of the study includes this observation, which is the first official comment to be made on the fare-differential issue by I.C.A.O.

* *"The Economic Implications of the Introduction into Service of Long Range Jet Aircraft," prepared by the Air Transport Committee of the International Civil Aviation Organisation, International Aviation Building, Montreal 3, Canada.*

—BUT MORE ARE ORDERED

IN the same week that I.C.A.O.'s report was published, American Airlines—as if to say "We don't believe it"—coolly ordered 50 more jets, bringing their orders for new turbine equipment to 110 aircraft worth $365m.

In an announcement on July 31 (see last week's issue of *Flight*) American announced an order for 25 Boeing 720s (which will be designated by American 707-023s) with an option on a further 25; and 25 Convair 600s—a development of the 880—also with an option on 25.

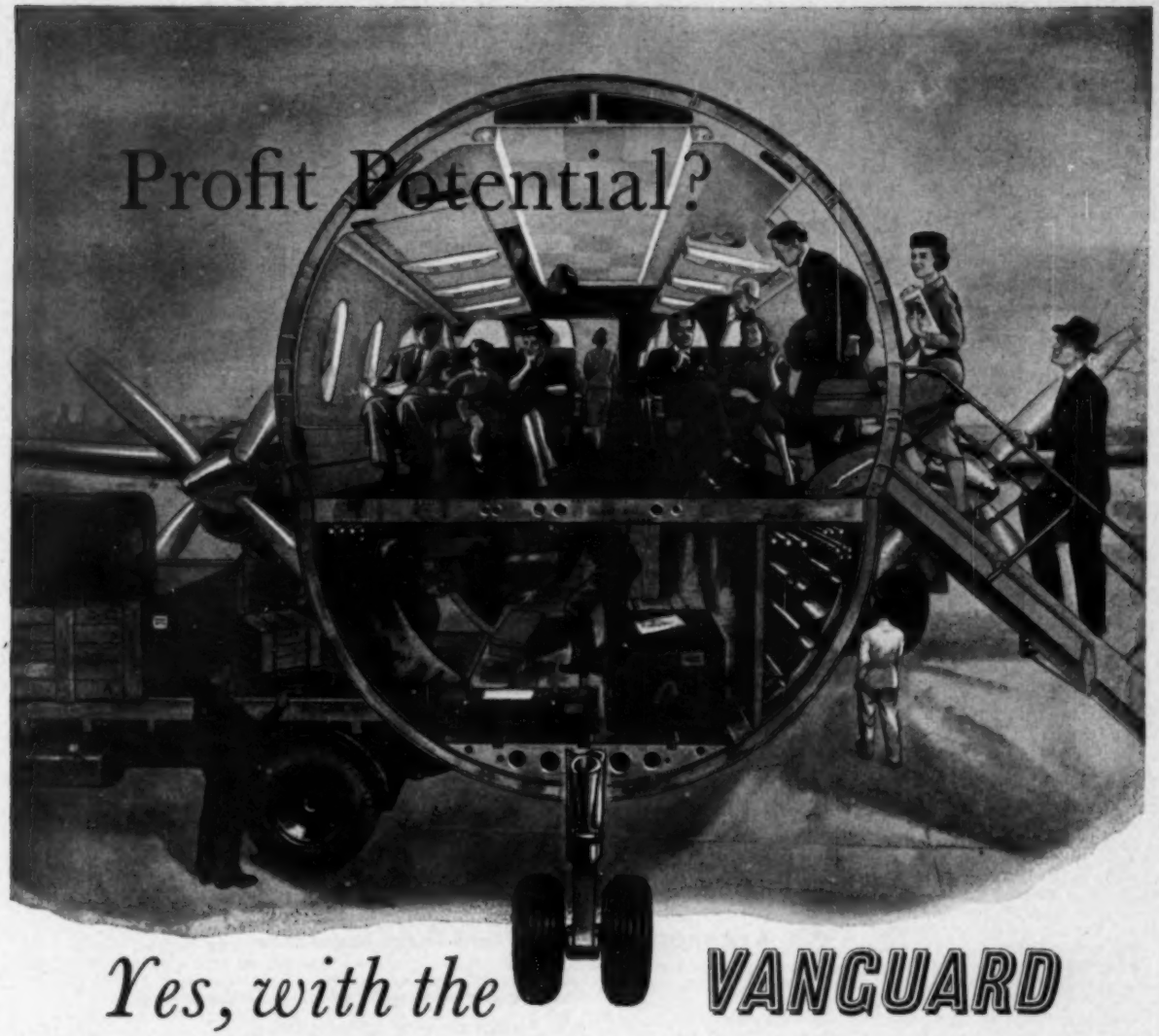
Thus American now has the largest turbine fleet so far ordered—110 aircraft, as follows:—

(1) 25 Boeing 707-123s for long-range use, deliveries of which will start during the next few weeks, to be completed by 1959. (The original order was for 30 Boeing 707-123s, but five have now been converted to 720s). (2) 25 Boeing 720s for medium-range service, deliveries to begin early in 1960 and to be completed in early 1961. (3) 25 Convair 600s for delivery in 1961-1962. (4) 35 Lockheed Electras, for delivery starting in 1958 and to be completed in 1960.

The distinction between the new Convair 600 and the 880 is marked; the 600 (foreshadowed in *Flight* of July 25) was, say Convair, "designed to American's special requirements." It is faster than the 880, having a maximum cruising speed estimated by Convair as 635 m.p.h., or 20 m.p.h. more than the maximum cruising speed claimed for the 880. This extra speed is apparently achieved by area-rule modifications in the form of two tapered projections or bulges protruding from the trailing edge of each wing; and by considerably increased power—15,000 lb thrust per engine as compared with 11,200 lb of the 880. The 600's power-plants will be the "aft-fan" General Electric CJ-805-21 development of the G.E. GJ-805-3 as fitted to the 880.

Other differences between the 600 and the 880 are greatly increased gross weight, 238,200 lb *v.* 178,500 lb; increased landing weight, 180,000 lb *v.* 132,800 lb; slightly increased wing area, up by 250 sq ft to 2,250 sq ft (though span remains the same); length up by 10ft to 139ft 5in; fuel capacity increased from 10,700 to 15,200 U.S. gal. All in all, the Convair 600 is a considerably larger, faster and heavier 880, with non-stop U.S. transcontinental capability. Seating is 90-120.

Why American should have ordered two types of medium jet remains rather a mystery. The Boeing 720 and the Convair 600 are of comparable capability, having always been closely competi-



Yes, with the VANGUARD

Profit potential of the Vickers Vanguard, at current tourist configuration, is at least 30% greater than that of any comparable aircraft on offer today. With higher density seating this advantage is doubled.

PERCENTAGE OF OPERATING COSTS
A.T.A. method

Stage Length Statute Miles	Maximum Revenue	60% Passenger load factor plus cap. freight Revenue.	Max. Potential Profit per trip.	60% Passenger load factor. Profit per trip.
	%	%	%	%
200	171	124	71	24
400	215	156	115	56
600	239	173	139	73
1,000	261	190	161	90
2,000	277	201	177	101

The basis for the above figures is : Tourist configuration at 97 passengers (up to 139 can be accommodated in Thrift class).
Standard ATA formula for direct costs. Direct costs taken as 100% of indirect costs. Passenger revenue 6 cents a mile; mail .03 cents a mile per lb. Freight .015 cents a mile per lb.

Airlines with an expanding future are choosing the Vanguard because it will take care of their needs for years to come.

With a payload of only 60% the Vanguard can make a profit on ranges as low as 200 miles and a profit of 56% on a range of 400 miles.

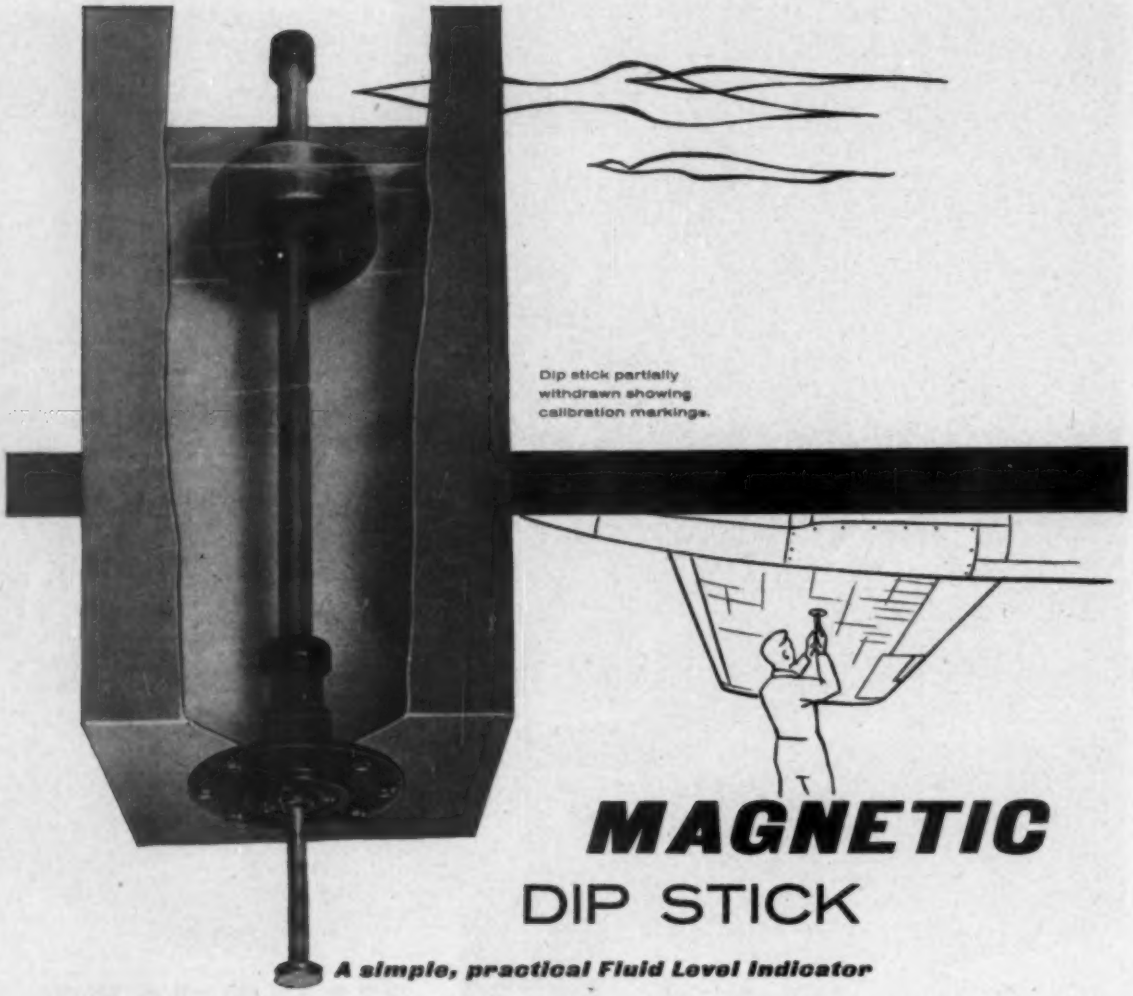
With capacity freight, a passenger load factor of 60% will yield 24% profit on 200-mile stages and 95% profit at stages from 1,000 to 2,000 miles.

Airlines will be able to offer passengers greater comfort, the attractions of 425 m.p.h. travel, and a background of 3 million airline hours' experience handed on by the Viscount.

VICKERS VANGUARD
FOUR ROLLS-ROYCE TYNE PROPELLER-TURBINE ENGINES

VICKERS-ARMSTRONGS (AIRCRAFT) LIMITED WEYBRIDGE SURREY

TGA AT569

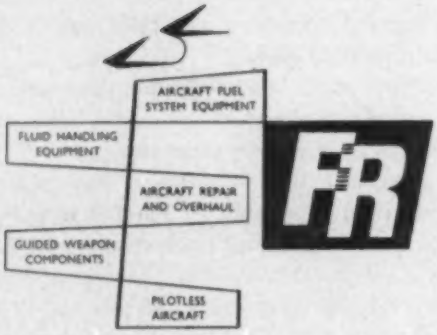


Dip stick partially withdrawn showing calibration markings.

MAGNETIC DIP STICK

A simple, practical Fluid Level Indicator

Demonstrated at the 1957 Farnborough SBAC Display, this new type indicator unit is tank installed and permits accurate fuel level readings to be made from the underwing surface without any risk of fuel spillage. The dip stick, which is external, is magnetically linked to an internal float. When not in use, it remains locked flush with the mounting flange. A number of variants is available, having different tube lengths. Although designed for aviation fuels, they are equally suitable for most other fluids.



Check these features

- Positive level indication
- Simple—no "electrics," nothing to go wrong
- No breaking of tank seals to check levels
- No spillage, leakage or fuel contamination

Flight Refuelling Ltd

TARRANT RUSHTON AIRFIELD, BLANDFORD, DORSET. TEL.: BLANDFORD 501 TELEGRAMS: REFUELLING BLANDFORD
ALSO AT RINGWOOD ROAD, WEST HOWE, BOURNEMOUTH, HANTS

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CIVIL AVIATION . . .

tive—as those who followed United's medium jet procurement may recall. Each is priced, without engines, at about $3m. There will be much confusion about American's decision to call the 720 by its previous designation 707-020; actually this is a more precise definition of what is no more than a lighter version of the short fuselage 707-120. First flight of the 600 will be in August, 1960: this will be followed by 8½ months' tests; and deliveries will be made as from June, 1961.

American's lease-back arrangements with the engine-manufacturers, reported last week, will reduce American's capital commitments by $80m. Cost of the G.E. and P. and W. leases, according to *Aviation Daily*, is based on amortizing engines over seven years, plus interest payable to the banks who will buy the engines from the makers (or from special subsidiaries). American will have an option to buy the engines at residual value, which will not be less than 10 per cent of first cost. American will overhaul the G.E. and P. and W. engines themselves; under the Allison lease (five year amortization), the makers will do overhauls.

Mr. C. R. Smith, American's president, says that the new fleet *will not require any additional financing*: whether finance will be required later will, he said, "depend upon earnings, which will depend on the authorization of adequate fares by the C.A.B." He then declared, in so many words, that the leasing arrangement had been made on the assumption that fares would be increased.

SAFARI COMPETITION

PUBLICATION of B.O.A.C.'s annual report for 1957-58 has stressed the growth of "serious competition" from the Safari services operated jointly by Airwork and Hunting-Clan. The period in question—April 1957 to March 1958 inclusive—was one in which B.O.A.C. were not alone in having severe difficulties to face. Throughout the early months of 1957 the Suez aftermath was felt by critical payload cuts resulting from the need for the Safari Vikings to avoid Egyptian territory. And the Vikings were only replaced by Viscounts on East- and Central-African routes in October and on West-African routes in January. As total Safari capacity remained unchanged, and as the bulk of Safari traffic moves in the (British) summer months, October to February being the slack period, the effect of Viscounts was not significant.

According to last July's Ministerial pronouncement on the Safari services, capacity would be pegged at a fixed level of total British capacity (i.e., the sum of all seats offered on B.O.A.C. and on Safari services). This device succeeds in limiting Safari traffic even more than appears: by operating on charter many services on behalf of dominion and colonial airlines, the Corporation can derive benefit from the carriage of traffic while causing an apparent drop in total "British capacity," thus limiting the growth of Safari capacity.

THOUGHTS ON AIRCRAFT REPLACEMENT

FOLLOWING an article in *The Times* on the future of the British aircraft industry, a letter appeared in the correspondence columns over the name of Mr. Eoin Mekie, chairman of Silver City, indicating that the article had made "no mention of the likely fate of thousands of relatively modern airliners facing premature obsolescence" and had taken little account "of the financial position of the airlines upon whom the future of the commercial aircraft manufacturers depends." Mr. Mekie explained that "a slight recession in air travel was coupled with a glut of fast modern piston-engined airliners about to be made obsolescent by the introduction of jets . . . ordered because airlines feared that their competitors would have the edge on them if they too did not order jets . . ." Because "the aircraft industries of the U.S. and Britain are causing airliners to be obsolescent long before they have worked for a reasonable proportion of their useful lives," Mr. Mekie suggested that "governments concerned must face up to the situation of paying ever-increasing subsidies to the airlines, or the airlines must combine so as to prevent themselves from becoming bankrupt."

Surprisingly, replies soon came not from manufacturers but from operators. Mr. F. Laker, managing director of Air Charter, endorsed the idea of inter-airline agreements, suggesting that the replacement problem "could well be dealt with by I.A.T.A." Lord Douglas of Kirtleside, chairman of B.E.A., admitted that "there is a lot with which I agree . . . about longer depreciation periods for the new types of civil aircraft . . . I raised (this subject) some weeks ago at a meeting of the Executive Committee of I.A.T.A. and intend to raise the matter again at the I.A.T.A. annual general meeting at New Delhi next October." To another correspondent, Mr. J. L. Jones, "it seems operators are forced to deny passengers the benefit of cheaper fares which might result from the continued use of obsolescent aircraft, while on the other hand the cheaper fares made possible by operating up-to-date equipment are not being allowed to the passengers."

In a final summing up, Mr. Mekie emphasized that "the possible reduced operating costs of a new type of aircraft can usually only show a hope of reduced fares if it is purchased *after* all depreciation has been written off the type which it replaces."

KINDLY LIGHT

RESEARCH by the Royal Aircraft Establishment into landing accidents, particularly those where undershooting of the runway has been the cause, has brought some interesting facts to light. It has been shown on the landing simulator at Farnborough that under certain conditions of weather or terrain it can be extremely difficult for a pilot to recognize an undershooting danger until he is very low. The phenomenon has been quite clearly established and the "recognition height" has been found to be only about 100ft above ground level. When undershoots do occur, it is usually because of a combination of circumstances rather than because of pilot error—for instance, an unsettled G.C.A. approach or small I.L.S. approach error coupled with rough air, a cross wind, haze or any of a multitude of other factors. And although the incidence of undershoot accidents is only about once in three million landings, the number of accident-free undershoots is very much higher. In about a quarter of all landing accidents, investigation has shown no defect in the aircraft or its equipment; what has gone wrong has frequently been ascribed to pilot error, but may in fact have been due to inefficient visual-approach indication.

It is not hard to see that as approach speeds rise and sinking speeds consequently become higher (reductions in the generally standard 3 deg glide-path angle are still only at discussion stage and in many cases may be very difficult to achieve) the position will deteriorate unless something positive is done. What is required is a clear and constant indication of absolute reliability that the aircraft is on the glide-path; it is apparent that G.C.A. directions can be given fewer times over a given distance as approach speeds rise, and a device to supplement I.L.S. information as the threshold is approached can also be very valuable.

Operational trials are now in progress on two new methods of visual glide-path indications; the Australian Cumming/Lane system comprising wing bar lights which, when in alignment indicate that the correct glide-slope is being followed, and the R.A.E.-Calvert visual glide-path indicator. The latter has been installed by the M.T.C.A. at Blackbushe (it became operational on July 14) and at Aberdeen, Prestwick, Belfast and Liverpool.

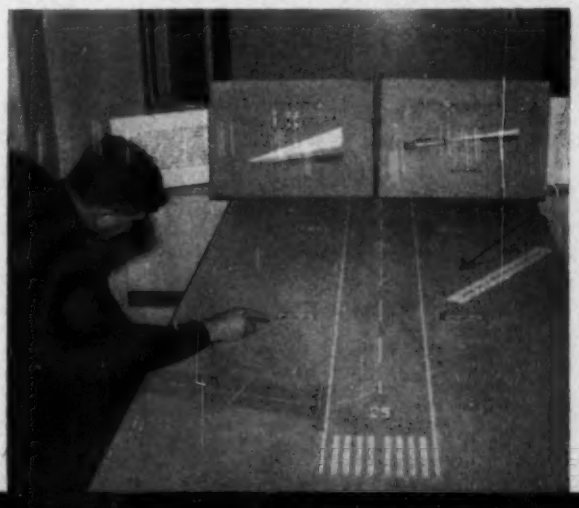
The elements of the system are illustrated in the accompanying photograph. It consists of two bars, about 30ft wide, spaced about 50ft from the runway edge at the fore-and-aft limits of the prescribed touch-down area (say 500ft from the threshold and 500 to 1,000ft apart). Each light consists of a sealed-beam lamp of high intensity—about 50,000 candles—the upper half of which is covered by a red filter. To avoid the condensation and colour-mixing troubles prevalent with amber-green-red glide-path indicators, no lens is used and the light shines through a "pin-hole" slot. For maximum safety a battery of three lights is used each side of the runway and the system appears as a square-box of four light-sources when the aircraft is correctly aligned with the glide-path.

As only red and white lights are used, the inter-zone colour is pink, and the possibility of incorrect colour-mixing cannot occur. Another advantage over earlier point-source systems is that the light pattern is easy to distinguish and the I.L.S. glide-path centre line is bracketed by a correct approach path of finite width right down to touchdown. Indication of position is given by both fore-and-aft bars showing red if the aircraft is too low, both white if it is too high and the near bars white and the far bars red (overshooting the first threshold marker, undershooting the second) if the aircraft is correctly aligned on the glide-path. The bars also provide roll guidance at touchdown.

The visual range is considered to be at least two miles by day and 8-10 miles by night, when it is dimmed by a factor of ten.

Both A.A.I. systems have been discussed by an I.F.A.L.P.A. study group. Opinions are divided, but it was agreed that premature standardization on either might result in installation delays.

A model in Shell-Mex House, London, shows the fundamentals of the R.A.E.'s visual glide-path indicator (see text). The operator is pointing to the model of the three-bar light; its actual size is indicated by the arrow on the right. Red and white colours only are used.



CIVIL AVIATION . . .

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While the ton-mile volume of passenger and mail traffic carried by Aer Lingus was virtually unchanged, freight traffic increased by 9 per cent, as a result of which total load was raised 2 per cent from 11.3m to 11.5m ton-miles. Meanwhile capacity was increased by 11 per cent from 16.0m to 17.8m ton-miles, load factor falling from 71 to 65 per cent.

Although total load increased by 2 per cent, revenue rose by 5 per cent from £2.9m to £3.0m. Passenger revenue increased by 2 per cent (£2.3m to £2.4m) largely as a result of higher average revenue rates (from 5.55 to 5.71 pence per passenger mile). But most of the increase came from charters and aircraft sales.

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* * *

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* * *

Hunting-Clan took delivery of the first of their two DC-6As on August 10. Intended for "Africargo" services, it was flown from Santa Monica to L.A.P. by Capt. L. B. Greensted.

* * *

New Zealand National are considering the purchase of 10 Friendships or Heralds to replace their fleet of 22 DC-3s.

* * *

Reports from Kenya suggest that East African Airways Corporation may buy Comet 4s. Other Comet 4 news last week was that B.O.A.C. have decided to have emergency passenger oxygen supplies installed before services start.

* * *

The first production DC-8 has logged 45 hours in the two months since its maiden flight on May 30.

* * *

Air India has just taken delivery of two L.1049Gs, bringing their fleet of Super Constellations up to 10.

* * *

North Central will purchase five Convair 340s from Continental early in 1959.

* * *

K.L.M.'s estimated loss for the first half of 1958 was 2.4m guilders as against a profit of 7.8m guilders for the corresponding period last year.

* * *

Three Vikings of the Queen's Flight have been purchased by Tradair, the Southend-based airline founded last November.

* * *

Britannia proving flights are now being conducted by C.P.A.L. between Vancouver and Tokyo in preparation for the inauguration of turboprop services on August 24.

* * *

A Lockheed Electra is expected to participate in a seven week sales tour of Europe in September and October before proceeding to New Delhi in time for the I.A.T.A. annual meeting.

* * *

The first scheduled Moscow - Paris flight took place on August 4, an Aeroflot Tu-104 carrying 16 passengers non-stop in 3 hr 51 min.

* * *

In addition to the three Friendships already ordered by D.E.T.A. (Mozambique) it is probable that a further three aircraft will be acquired by D.T.A. (Angola).

* * *

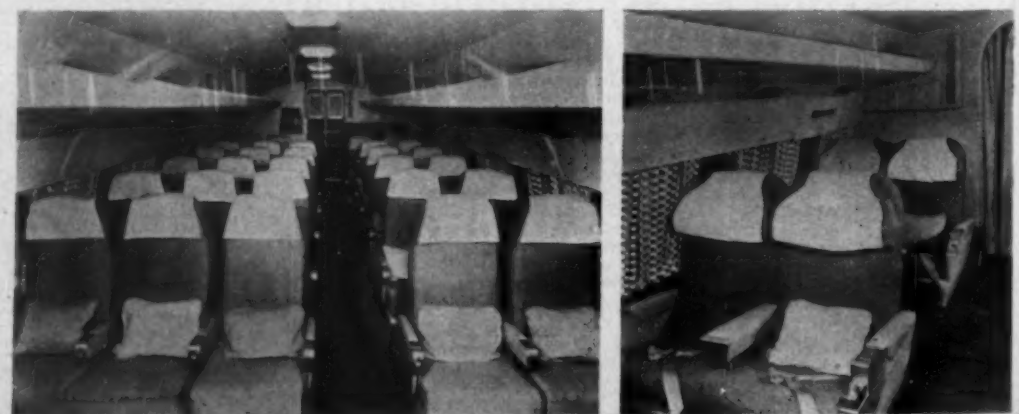
The large number of passengers (44,000 last year) having to change at London when flying from Scotland to the Continent has led the Scottish Council for Civil Aviation to approach B.E.A. suggesting the operation of direct flights.

* * *

A $342,370 A.M.B. contract for a survey and forecast of U.S. air traffic has been awarded to Booz, Allen and Hamilton, a Chicago firm of management consultants. This contract will supplement the research carried out for the Curtis Report.

* * *

Eagle Airways (Bermuda) have applied to the C.A.B. to serve Washington and Baltimore in addition to New York. It is expected that Mr. Harold L. Graham, until recently the president of Resort Airlines, will become president of the new carrier.



First interior pictures of a B.O.A.C. Comet 4, showing (left) tourist and (right) first-class layouts. All seats are by Microcell. Comet 4 decor will be a departure from B.O.A.C.'s traditional blues and greys.

DEVELOPMENT ENGINEERS

B.E.A. require the following staff in their Project and Development Branch at London Airport:

(A) DEVELOPMENT ENGINEER (AIRCONDITIONING) for work on airconditioning, pressurisation, oxygen, sound proofing and ice protection. *Salary* £910 to £1,085, or £1,025 to £1,250. *Qualifications:* H.N.C. or equivalent; 5 years' experience in this field; fit for flying.

(B) DEVELOPMENT ENGINEER (INSTRUMENTS) for project work on Instrument Systems and Autopilots; design of helicopter experimental equipment. *Salary* £1,025 to £1,250, or £1,120 to £1,435. *Qualifications:* Degree in Science or Engineering or Graduate Membership of appropriate Engineering Institution. Experience in autopilot or instrument system design or autopilot stability and control analysis.

(C) DEVELOPMENT ENGINEER (ENGINES) for current development of Power Units and defect investigations. *Salary* £910 to £1,085, or £1,025 to £1,250. *Qualifications:* Recognised training; H.N.C. or equivalent; several years practical experience on aero engines with design and development knowledge.

(D) TWO DEVELOPMENT ENGINEERS (AIRCRAFT) for work on aircraft interior layouts and furnishings and safety equipment. *Salary* £910 to £1,085 or £1,025 to £1,250. *Qualifications:* Recognised training; H.N.C. or equivalent; considerable experience in drawing office and aircraft interior development.

(E) DEVELOPMENT ENGINEER (PROPELLERS) for current development of propellers and auxiliary equipment. *Salary* £910 to £1,085 or £1,025 to £1,250. *Qualifications:* Recognised training; H.N.C. or equivalent; several years experience on propellers and associated equipment; propeller design experience desirable.

(F) DEVELOPMENT ENGINEER (ENGINES) for work in connection with overhaul of Propeller Turbine Engines, defect investigations, salvage schemes, life development. *Salary* £910 to £1,085 or £1,025 to £1,250. *Qualifications:* Recognised training; H.N.C. or equivalent; several years experience on gas turbine engines, preferably with overhaul experience.

Salary range in each case will depend on qualifications and experience. Three weeks holiday, Pension, Accident and Sick Pay Schemes. These posts offer a secure future.

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BRITISH EUROPEAN AIRWAYS

Engineering Base, London Airport, Hounslow, Middlesex

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As this issue went to press Bristol announced a Cubana repeat-order for two more Britannia 318s for delivery next spring. The two aircraft ordered in May 1957 will be delivered by the end of this year. Both orders together are valued at $14m.

* * *

Hunting-Clan took delivery of the first of their two DC-6As on August 10. Intended for "Africargo" services, it was flown from Santa Monica to L.A.P. by Capt. L. B. Greensted.

* * *

New Zealand National are considering the purchase of 10 Friendships or Heralds to replace their fleet of 22 DC-3s.

* * *

Reports from Kenya suggest that East African Airways Corporation may buy Comet 4s. Other Comet 4 news last week was that B.O.A.C. have decided to have emergency passenger oxygen supplies installed before services start.

* * *

The first production DC-8 has logged 45 hours in the two months since its maiden flight on May 30.

* * *

Air India has just taken delivery of two L.1049Gs, bringing their fleet of Super Constellations up to 10.

* * *

North Central will purchase five Convair 340s from Continental early in 1959.

* * *

K.L.M.'s estimated loss for the first half of 1958 was 2.4m guilders as against a profit of 7.8m guilders for the correspond .g period last year.

* * *

Three Vikings of the Queen's Flight have been purchased by Tradair, the Southend-based airline founded last November.

* * *

Britannia proving flights are now being conducted by C.P.A.L. between Vancouver and Tokyo in preparation for the inauguration of turboprop services on August 24.

* * *

A Lockheed Electra is expected to participate in a seven week sales tour of Europe in September and October before proceeding to New Delhi in time for the I.A.T.A. annual meeting.

* * *

The first scheduled Moscow - Paris flight took place on August 4, an Aeroflot Tu-104 carrying 16 passengers non-stop in 3 hr 51 min.

* * *

In addition to the three Friendships already ordered by D.E.T.A. (Mozambique) it is probable that a further three aircraft will be acquired by D.T.A. (Angola).

* * *

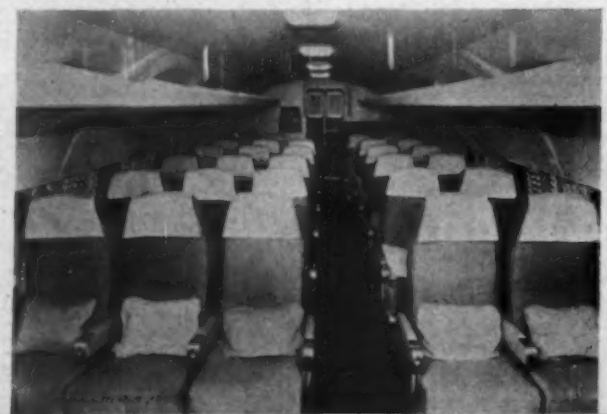
The large number of passengers (44,000 last year) having to change at London when flying from Scotland to the Continent has led the Scottish Council for Civil Aviation to approach B.E.A. suggesting the operation of direct flights.

* * *

A $342,370 A.M.B. contract for a survey and forecast of U.S. air traffic has been awarded to Booz, Allen and Hamilton, a Chicago firm of management consultants. This contract will supplement the research carried out for the Curtis Report.

* * *

Eagle Airways (Bermuda) have applied to the C.A.B. to serve Washington and Baltimore in addition to New York. It is expected that Mr. Harold L. Graham, until recently the president of Resort Airlines, will become president of the new carrier.



First interior pictures of a B.O.A.C. Comet 4, showing (left) tourist and (right) first-class layouts. All seats are by Microcell. Comet 4 decor will be a departure from B.O.A.C.'s traditional blues and greys.

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(A) DEVELOPMENT ENGINEER (AIRCONDITIONING) for work on airconditioning, pressurisation, oxygen, sound proofing and ice protection. *Salary* £910 to £1,085, or £1,025 to £1,250. *Qualifications:* H.N.C. or equivalent; 5 years' experience in this field; fit for flying.

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FROM Derby Aviation, Ltd., of Derby Airport, Burnaston, Derby:—

APPLICATION No. 1168/1 for an amendment to the terms of approval of the Normal Scheduled Service which they are authorised to operate on the route Derby (opt.) - Nottingham (opt.) - Birmingham - Toulouse (technical) - Ibiza with Dakota aircraft at a frequency of one return flight weekly so as to permit them to make an optional traffic stop at Manchester (Ringway).

FROM Skyways, Ltd., of 7 Berkeley Street, London, W.1.:—

APPLICATION No. 792/4 for an amendment to the terms of approval of the Normal Scheduled Service which they are authorised to operate on the route Lympne - Vichy and/or Valence (or Lyons for Valence), so as to permit them to operate as follows on the Lympne - Lyons sector:—

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Printed in Great Britain for the Publishers, ILIFFE & SONS LTD., Dorset House, Stamford Street, London, S.E.1, by SUN PRINTERS LTD., Watford and London. *Flight* can be obtained abroad from the following: AUSTRALIA AND NEW ZEALAND: Gordon & Gotch, Ltd. INDIA: A. H. Wheeler & Co. CANADA: The Wm. Dawson Subscription Service, Ltd., Gordon & Gotch Ltd. SOUTH AFRICA: Central News Agency, Ltd.; Wm. Dawson & Sons (S.A.), Ltd. UNITED STATES: Eastern News Co., 306 West 11th Street, New York 14.

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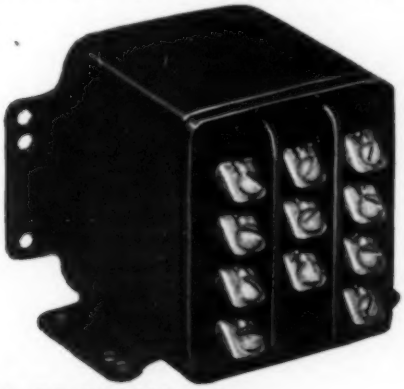

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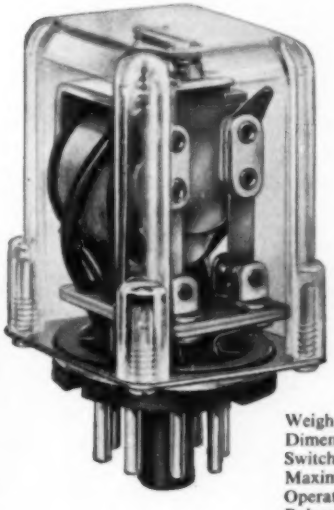

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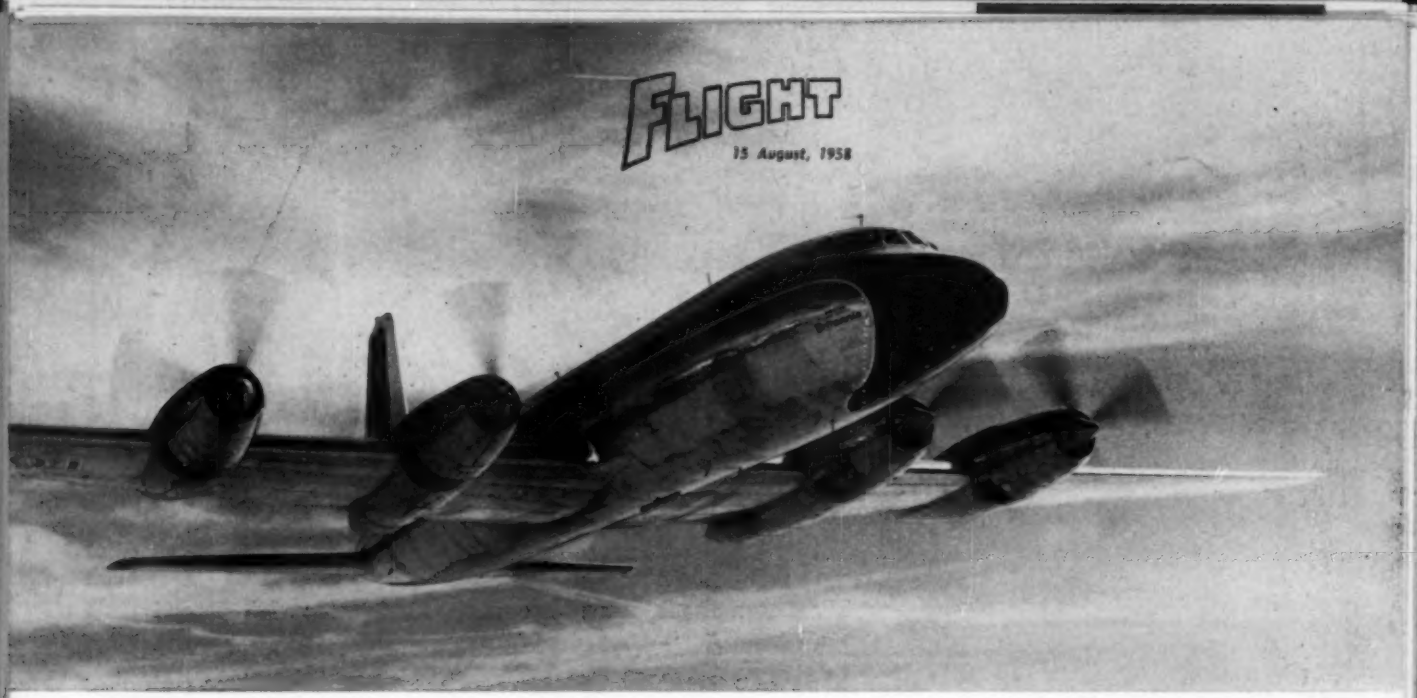

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